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OKLAHOMA
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
C. P. BLACKWELL, Director

Report of Proceedings of the Second Southwest Soil and Water Conservation Conference

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TABLE OF CONTENTS

Welcome ---- 5
C. P. Blackwell, Dean of Agriculture
Oklahoma A. and M. College

Objects of the Meeting ---- 6
O. B. Martin, Director of Extension
College Station, Texas

Research Program of Soil Erosion in Oklahoma ---- 8
C. P. Blackwell

The Oklahoma Soil Erosion Survey ---- 9
N. E. Winters, Head of Field Crops and Soils
Oklahoma A. and M. College

The Soil Conservation Research Program for the Southwest ---- 11
Dr. A. G. McCall, Bureau of Chemistry and Soils
U. S. Department of Agriculture

Experimental Work on Soil Erosion and Water Contro lin Texas ---- 16
R. E. Dickson, Superintendent
Spur Experiment Station

Experimental Work in Texas ---- 18
Robert A. Norton, Temple, Texas

Experimental Work in Kansas ---- 19
F. L. Duley, Kansas Experiment Station

Experimental Work at Hays, Kansas ---- 22
Raymond R. Drake, Hays Station

Soil Erosion in Western Mississippi ---- 23
G. H. Lentz, Silviculturist
Southern Forest Experiment Station

There Can be Too Little Erosion ---- 32
M. F. Miller, University of Missouri
Columbia, Mo.

Study of Runoff From Terraced Fields ---- 36
R. W. Baird, Asst. Prof. of Agricultural Engineering
Oklahoma A. and M. College

Address ---- 39
W. J. Holloway, Governor of Oklahoma

Soil Erosion Work at Guthrie, Oklahoma ---- 40
Samuel W. Phillips

Results of Experiments on Erosion Control of the Guthrie Soil Erosion Experimental Farm ---- 46
R. E. Ramser

Engineering Experimental Program of the Southwest ---- 54
L. A. Jones, Senior Drainage Engineer
U. S. D. A.

Handling Runoff from Terraced Fields ---- 55
L. E. Hazen, Agricultural Engineer
Oklahoma A. and M. College

Report on Protecting Road and Hillside Ditches with Concrete Baffles ---- 57
W. H. McPheeters, Member, Soil Erosion Committee
A. S. A. E.

TABLE OF CONTENTS—(continued)

Soil Erosion 62
H. H. Bennett, in Charge, Soil Erosion and Moisture Conservation Investigations
U. S. Bureau of Chemistry and Soils

The Texas Extension Program in Soil Conservation and Results 70
O. B. Martin

The Texas Extension Program in Soil Conservation and Results 71
M. R. Bentley, Agricultural Engineer
Texas A. and M. College

Extension Program in Bowie County, Texas 73
W. R. Holsey, County Agent, Bowie County

The Missouri Extension Program in Soil Conservation and Results 74
M. F. Miller, Assistant Dean, School of Agriculture
University of Missouri

The Kansas Extension Program in Soil Conservation and Results 76
Dr. F. L. Duley, Kansas Experiment Station

The Louisiana Extension Program in Soil Conservation and Results 78
W. B. Mercier, Director of Extension
Louisiana

The Arkansas Extension Program 79
W. J. Burleson, University of Arkansas

The Oklahoma Extension Program in Soil Conservation and Results 80
E. E. Scholl, Asst. Director of Extension
Oklahoma A. and M. College

Extension Work in Payne County, Oklahoma 83
Lloyd Godley, County Agent

A Type of Education that Functions on the Farm 84
E. B. Nelms, Oklahoma State Supervisor of Vocational Agriculture

How can the Press Assist in the Soil and Moisture Conservation Program? 86
Frank Briggs, Editor, Farm and Ranch
Dallas, Texas

What the Federal Land Bank of Houston is Doing 88
A. K. Short, Conservation and Terracing Agent

Summary 89
R. H. Bush, Chilean Nitrate of Soda Educational Bureau
Tyler, Texas

Summary 90
Victor H. Schoffelmayer, Dallas News
Dallas, Texas

Officers Elected 91

Resolutions 91

List of Delegates and Visitors 92

WELCOME

By

C. P. BLACKWELL, Dean of Agriculture

Oklahoma A. and M. College

In the absence of Dr. Henry G. Bennett, President of the Oklahoma A. and M. College, I would like to extend to you a very hearty welcome. I suppose most of you understand that you are welcome, that A. and M. colleges in general are public institutions, and that organizations of this kind are not only welcome, but very desirable groups on our campus, and the facilities of this institution are at your disposal while you are here. We are meeting in the oldest building on the campus, and at one time the only building on the campus.

Without further preliminary remarks I just want to say that we consider this one of the most important meetings that has been held at this institution this year. We have had a great many short courses of various kinds, but we consider this probably the most important meeting that we have had because of the significance of the work which you men are doing and in which you are interested.

At this time I am going to call on the President of this Association, Mr. O. B. Martin, Director of Extension at College Station, Texas, to discuss with you the objects of the meeting.

OBJECTS OF THE MEETING

By

O. B. MARTIN, Director of Extension
College Station, Texas

Mr. Chairman, ladies and gentlemen:

That might be like the nigger's sermon—short but brief. In our first annual meeting I think we got these objects before us pretty well and the question now is, what are we going to do about it? "Where are we at?"

I have listed four objects:

(1) To take stock of the situation

(2) To get a vision of the future

(3) To unify our efforts

(4) To arouse the folks

You may state some in addition to these. In taking stock of the situation we want to know something about the soil losses, the water losses, and the human losses. It was brought out at our meeting last year that some engineer during the Mississippi flood had figured out the possibilities of connecting the head waters of the Arkansas with the head waters of the Rio Grande and getting some of that water that goes down the Mississippi. The southwest is almost all included in the area of the Mississippi and there are tremendous soil losses as the Mississippi River will testify, and there are tremendous water losses, and there are tremendous human losses. We have been so busy in this part of the world that we do not stop to appreciate the human losses because the population is constantly increasing in this territory by people coming in. When you take the soil losses and water losses and human losses you will appreciate the importance of the Bible expression "By the still waters."

I was especially interested in the demonstrations which we were concerned about in the meeting here, and the thing that stuck in my mind most of all was that even in a somewhat broken country, in a time of these tremendous rains, on terraces one-half or one mile long, often there was practically no water losses. I recall one situation where a farm had been terraced, this is the second year, and there was only one place, in an alfalfa field, where the water just barely came over. They told me that two years ago an automobile could have been put in that place. Now there was practically "still water" on that whole farm. Just across the hill was a farm that had been neglected for many years and the contrast was great. The finances of the man who lived on that place were in about the same condition as the farm.

The worst part of it is the human losses. I was impressed there, as I was at a great many of the other demonstrations, by the fact that the county agents who succeeded in getting crops that hold the water, instead of so much cotton right in the beginning, were the ones who were most successful and furnished the demonstrations that were the most successful. That is where the fine cooperation between the experiment stations and the extension divisions comes in. Those crops mean not only success this year, but in the years to come. The prescription of crops comes even before the prescription of terracing.

I think we are making considerable progress in work of this kind. There is evidence of this by the fact that some of our extension people are inspired to the extent of poetry:

The face of Mother Earth is scarred
By gullies deep and wide,
The helpless soil, robbed of its guard,
Runs down to meet the tide.

The fields that once were fair to see,
Their rich loam thrown up free,
Are now washed bare of fertile soil,
And meagerly repay man's toil.

A time there was in olden days,
When first thereon man's eye did gaze,
Those fields were covered everywhere
With trees and grass as thick as hair.

Thus Nature, adequately dressed,
Sought wisely to protect her breast
From gashes torn by storms that pressed
From north and south and east and west

Dame Nature then was but a virgin,
Her family since has been emergin',
Until her restless children roam
The entire globe and call it home.

To feed so many hungry faces,
We've torn down ancient forest places;
To make all famines false alarms
We've ripped the prairie into farms.

All this is good—
I would not ban it,
Yet rains that beat now on our planet,
Will wash it off unless we dam it.

Old Nature's wounds need bandaging,
Lest all her strength go vanishing,
So pray, good friend, do not embarrass,
But honor him who stops to terrace.

Henry Grady did a great deal for the agriculture of the South Atlantic States. In a talk which he made in Dallas, Texas, way back in the '80s, he saw the importance of conservation, and he saw the importance of the balance in nature. He saw the importance of maintaining the fertility of the soil. He had been up against it in the red hills of Georgia. He looked forward to the day which is coming now as the result of the importation of cotton mills and feed mills and paper mills and milk plants and other factories throughout the southwest.

The third object that I outlined was that we unify our efforts and this meeting represents the entire southwest. We can accomplish so much more in our states and throughout this whole territory by unifying our efforts as an organization of states and in cooperation with the United States Department of Agriculture. The same fundamental principles and the same methods and the same kind of results come everywhere and if this work is based on the right principles and if we use the right methods, there is no question about the outcome. By the same methods I do not mean dull uniformity. There is always a possibility of new methods. The results that come in from County Agents furnish us new material all the time. It is not that monotonous uniformity. That same editor of our staff returns to poetry and uses another little poem which is called "Heritage."

I do not lift my voice in praise
  Of men who spent their life long days
A-mining richness from my fields
  To leave me well-nigh starving yields.

The heritage that's left to me—
  Of deadened soil and blighted tree—
Is not the reason I revere
  The memory of the pioneer.

The pioneer had skill and vision
  To grab what he thought sure was his'n;
The rights of future generations
  Were quite without his calculations.

He did what we would do, no doubt,
But yet I see no cause to shout
In praise of such a thieving lout
Who put my once rich fields to rout.

Folks tend to worship what is past
And mold it in heroic cast—
Including even robber barons
Who've left behind infertile barrens.

In my own list of heroes bold
There's one old codger I'll cut cold
No saint in plaster he can be
For he's the man who ruin't me.

Now the last object that I want to suggest is to arouse our people, show them the success, contrast the failures, and inspire them to action. A great deal of responsibility rests upon a new country in this matter—greater than that which rests upon the old. The damage has already been done in the old. It is the same question that Rip Van Winkle was up against. He had been asleep for 20 years. Almost the only things he could recognize, when he awoke, were the ravines and gullies. He did, a few days afterwards, recognize his son because he was the facsimile of what Rip himself had been 20 years before, but in Washington Irving's account of Rip Van Winkle's awakening the thing that stands out is that the gullies were there, and the ravines were there. A great deal more of the soil was gone, and the water had been going over it. Some of the abandoned farms in the east represent Rip Van Winkle being worse than asleep. The question is, how much of it out this way represents Rip Van Winkle asleep? That depends upon such meetings as this for action.

RESEARCH PROGRAM OF SOIL EROSION IN OKLAHOMA

By

C. P. BLACKWELL, Dean of Agriculture

Oklahoma A. and M. College

I will only briefly outline the Oklahoma program as some of the specialists will give details of various parts of it during the meeting. We have made some estimates of the losses in Oklahoma through erosion and a detailed report will be made on the soil losses.

Our estimates of the crop losses show that cotton has declined in yield during the past 20 years by approximately 100 pounds of lint per acre. This means an increased cost of production of about seven cents per pound, a total of more than $40,000,000 per year on the entire Oklahoma crop. In addition, the total loss from depleted soils must include the amount of crops not produced, that would have been grown if the yield had kept up to the original level.

We are losing in all Oklahoma crops together more than $50,000,000 in increased costs and at least an additional $50,000,000 from loss of crops not produced by the worn land.

The program for the state includes cooperation with the erosion station at Guthrie established by the Federal Bureau of Public Roads and Bureau of Chemistry and Soils and some individual fields. The state legislature appropriated $20,000 for soil erosion and soil survey work and approximately one-half of that is being devoted to erosion. In addition to cooperating with the work at Guthrie, the state has established several other fields. One is at Lone Grove, eight miles west of Ardmore, one at Heavener in the southeastern part of the state where the rainfall is about 40 inches per year,

and one at Pauls Valley in connection with the State Reformatory. Mr. R. W. Baird had started some work here at Stillwater, also, which is just now under way.

Before starting the new experiments, the question of where is the greatest need in Oklahoma came up. A survey was proposed and Dr. J. T. Sanders suggested the use of crop meters as a method of making it. The meters were put on two cars and two men sent out in each car. The meters have 12 keys and each key represented a different type of soil or erosion. This meter survey is accurate within a reasonable percentage and gives rather definite information on state conditions.

I am going to ask Dr. N. E. Winters, head of the department of Field Crops and Soils to report on the erosion survey made this spring.

THE OKLAHOMA SOIL EROSION SURVEY

By

N. E. WINTERS, Head of Field Crops and Soils

Oklahoma A. and M. College

In order to secure a state-wide picture of soil erosion for the State of Oklahoma we attempted to make an erosion survey by means of a rather unique method; in fact, it is the first time that this method has been used so far as we know.

Two crop meters were secured from the Kansas and Oklahoma State Statistical Departments. The kind we used has 12 keys attached to the instrument board of an automobile, which is connected with the front wheel of the car, operating like a speedometer. It also has a black key which when pushed in throws out of operation all of the 12 white keys, and leaves only the general mileage recorded. Each white key has its own recording apparatus which operates independently of every other white key, and when one key is pushed none of the other 11 is in operation. Each key represented a particular soil condition. For example, white key number one in this work stood for cultivated land not eroding; key number two, cultivated land that is terraced; key number three, cultivated land suffering from erosion; key number four, cultivated land slightly gullied; key number five, cultivated land badly gullied so that farm machinery could not cross them. The other conditions included in this survey were pasture land not eroded, gullied pasture land, abandoned land due to erosion, abandoned land due to other causes, woodland, meadow, non-agricultural land such as oil fields, cities, rivers, etc.

This work was started in November, 1929 and continued until March of this year when the rush of planting season made it impossible to continue the work.

Two cars were used in this work, and two men in each car—one man would drive the car and the other would operate the keys of the crop meter, both of them together discussing the soil conditions and deciding the classification of the same.

The actual operation consisted of classifying the land on one side of the road while driving along and pressing the proper key corresponding to the classification. This survey was made by counties. Usually from one to two days driving were required for each county, going from north to south, and from east to west across the county in order to get a representative cross-section of the same. A total of 9,600 miles were travelled in making this survey, an average of 200 miles per county. The results are not absolutely

accurate, but do represent a good average for the State. During the time available 48 of the 77 counties in the State were surveyed, and an average for the 48 counties is taken as representing the percentage condition for the whole state.

In analyzing the results, the State is divided into rainfall districts as you will note on the chart, from the 20 inches or less in the western and northwestern part of the State to the 45-inch rainfall belt of the southeastern part of the State.

In studying the results of this survey by counties it has been noted that a county with rough topography suffers much more from erosion than a county in the same rainfall belt that has a comparatively level topography. For example, Grant and Caddo counties are in the same 30-inch rainfall belt. Grant county has 446,000 acres in cultivation—212,000 acres are visibly suffering from erosion, less than 50% of the cultivated fields suffering from erosion; whereas in Caddo county we have a much rougher topography and with 542,000 acres in cultivation 491,000, or over 87½%, are washing away.

Another factor which has a big influence on erosion is the percentage of land in cultivation. In the southern Ozarks with 45 inches of rainfall the percentage of loss from erosion is less than it is in the 35-inch rainfall belt with a higher percentage of the land in cultivation.

I wish to call your attention to the difference in abandoned land between the western part of the State and the eastern part. In the western part of the State under the 20 and 25-inch rainfall belts there has been practically no land abandoned except where erosion has forced the abandonment, while farther east there has been a great deal of land abandoned due to causes other than erosion. In the western part of the State for the last few years there has been an extension of cultivated land, and practically no land has been abandoned due to economic conditions.

The results indicate that, of the total area of 44,000,000 acres in the State, we have 16,000,000 acres in cultivation; of the 16,000,000 acres now in cultivation nearly 13,000,000 acres are washing, that is 13 acres out of every 16 in cultivation as an average for the State, are suffering from sheet erosion, or from gullying, slightly or badly. Nearly 6,000,000 acres are in gullies, and 374,000 acres are so badly gullied that good farm machinery cannot cross them.

It is needless to say that the results of this survey were a great surprise to all of us. We realized of course before making this survey that erosion is a serious problem and that it needed immediate attention, but I believe none of us appreciated just how bad it is.

An effort was made to determine the amount of land that had been abandoned in the last three or four years considering vegetation, weed and grass growth, etc., and the results indicate that there has been in that length of time over 1,359,000 acres abandoned in this State due to soil erosion.

We had been told that our land was being abandoned as unfit for taxation at the rate of 2,000,000 acres per year, but this survey indicates that the abandonment is going on even faster than that. It emphasized the urgent need for action to curtail this tremendous loss from erosion.

DR. CHARLES N. GOULD, Geology Department, University of Oklahoma, Norman:

I have found that some soil formations are more susceptible to soil erosion than others. The sandy soils in the western part of Oklahoma are very erosive while shales and clays do not erode easily. The black hills in Texas are our greatest problem in soil erosion. Therefore if you

take a colored geological map of Oklahoma you can tell which soils will erode easily and which will not. Grant county is comparatively level and Caddo county is hilly and that again is a geographic factor. The basis of erosion is largely geographic.

DEAN C. P. BLACKWELL:

We had in mind bringing together, first of all, the facts, to get together all of the research information which is available. Last year we had some discussion of that at College Station, and there was some feeling that we knew about that already, but a great many of us thought there was not enough available information. We had thorough proof of that this spring. We had a two-inch rain which fell in about 30 minutes time, which made a number of converts to erosion control in this State, so in view of this fact we want to keep in mind that we are trying to bring together all the facts about soil conservation.

THE SOIL CONSERVATION RESEARCH PROGRAM FOR THE SOUTHWEST

DR. A. G. McCALL, Bureau of Chemistry and Soils
United States Department of Agriculture

The little poem reminded me of the fact that I have in my pocket a clipping from a paper—a little poem contributed by some of our western friends, and I am just going to read that as a little preamble to the paper which I am going to give:

Hordes of gullies now remind us
We should build our lands to stay,
And departing leave behind us
Fields that have not washed away;
When our boys assume the mortgage
On the land that's had our toil,
They'll not have to ask the question
Here's the farm, but where's the soil?

This occasion brings to my mind recollections of my boyhood days in Ohio and the thrills which I experienced in reading the stirring accounts of the opening to settlers of the government lands in Oklahoma and the Indian Territory. These thrilling narratives were brought to us by the weekly newspaper delivered to us by the steamboat which carried the semi-weekly mail to our community on the north bank of the Ohio river. Our interest in these openings and allotments was further enhanced by letters from some of our relatives and neighbors who had gone West to participate in the drawings with the hope that they would find in these new regions a congenial place and fertile acres upon which to establish a new home. I have vivid recollection of the hardships and privations suffered by these early settlers and the enthusiasm and the hope with which they looked forward to the day when they would be able to "prove up" their claim and receive from the Government at Washington a deed to their quarter section, which had cost them little in the matter of cash outlay but much in the form of privation and expenditure of human energy.

As I now ride over these once fertile lands I cannot avoid being impressed with the fact that a mere deed from a generous Uncle Sam is not sufficient to hold the fertile soil with which Nature had so generously clothed the prairie country of the West and Middle West. In every direction I find rolling areas of what was once productive soil now dissected by gullies, and comparatively level land that has been robbed of its rich

mellow surface through the destructive action of rainwash on the unprotected surface of cultivated fields and over-grazed range lands. On the rough and rolling lands the destructive effects of unrestrained runoff are called to our attention by the presence of gullies and deep channels. The absence of gullies, however, must not be taken as evidence that destructive soil erosion has not occurred. As the result of unwise methods of soil management, much of our comparatively level land has been subjected to sheet erosion that is slowly but surely removing the surface layer as evidenced by the appearance of light colored clay spots indicating the areas where the surface soil has been removed leaving the subsoil exposed. This subsoil is more difficult to plow, less absorptive of rainfall and much less productive than the original mellow surface soil.

The findings of the soil erosion survey of Oklahoma which Doctor Winters has told us about are so pertinent to the problem of a sound policy of national economy in connection with the efficient use of our agricultural and grazing lands that I want in the outset, to express my very great appreciation of this excellent piece of work. Although this survey was of a general nature, there can be no mistaking the meaning of the conclusions reached. When we consider that of 13 million acres out of a total of approximately 16 million acres of cultivated land in the State is suffering from erosion, with nearly six million acres of this in a gullied condition, we begin to realize the seriousness of this soil wastage through processes of unrestrained soil washing.

The investigations conducted by the Soil Survey of the United States Department of Agriculture has revealed the same general trend of wasteful erosion that the survey of Oklahoma has revealed.

The work of the Soil Survey of the Bureau of Chemistry and Soils, the investigations conducted by the Bureau of Public Roads and the forestry and range management studies carried out by the Forest Service have all served to indicate the wide extent to which the lands of the United States have been subjected to destructive erosion. For example, some time ago, we made a very detailed survey of a typical valley in the loessial uplands of northeastern Kansas. Here we found that 86 per cent of the upland area, comprising the greater part of the valley, had lost soil by erosion to a depth of from 8 to 40 inches since it was cleared about 42 years ago. Of 120 acres surveyed, 34 acres had lost soil to an average depth of 11 inches, 45 acres had lost 18 inches, 10 acres 21 inches, 2½ acres 23 inches and 1⅛ acres had lost 3¼ feet of soil. There was no question about the accuracy of these measurements. The yardstick was found in small areas where the original timber growth remained intact. From the profile of this virgin soil it was possible to secure a very accurate picture of what had taken place. We have made similar surveys in various other regions where erosion is extensive and serious. The findings have been generally the same, that is, they show that within comparatively short periods all or the better part of the fertile topsoil has been swept from numerous sloping areas, leaving comparatively unproductive soil, which is often too poor for any possibility of profitable yields without heavy expenditures for fertilizers or resort to growing soil-improving crops solely to rejuvenate the erosion-impaired land.

Furthermore, we have been able to locate something like 17½ millions of acres of land that was formerly cultivated and considered fair to good soil, which has been so despoiled by erosion that it can be identified at once either as destroyed land or as land so dissected that farmers cannot afford to undertake its reclamation. This is our minimum estimate of the area thus despoiled. Of the large areas of abandoned land throughout the country, we have not yet undertaken to ascertain, conclusively, what proportion of it has been abandoned as the result of erosion. I would not

be in the least surprised, when we come to make such a survey, to find that this visible area of 17½ million acres of devastated land is but a small fraction of the actual area ruined by excessive soil washing. That Oklahoma finds more than a million acres of the 1,694,000 acres of farm land classed as abandoned representing land turned out because of erosion; that the State of Iowa has recently estimated the area of erosion-devastated land within her boundaries at a million and a half acres; and that our own Bureau has gone into various parts of the country and has found by actual survey that from 50 to 100 thousand acres of land formerly cultivated have been destroyed in single counties, forces the conclusion that we have been considerably in the dark in this country with respect to what is going on, and what has been going on for a very long time, in the matter of soil impoverishment and soil destruction by erosion.

Our investigations have convinced us that when we come to consider the more serious aspects of erosion, the extent of completely devastated land, bad as it is, does not give us the full story of the wastage by any means. We are finding that sheet erosion is going on wherever there is enough rainfall to cause water to run downhill. Professor Miller has found that on a very extensive and important agricultural soil in Missouri more than 40 tons of soil per acre annually, for an average of 12 years, have been washed off slopes no steeper than 3.6 per cent. In West Texas, on a two per cent slope, 27 inches of rainfall have removed 40 tons of soil per acre per year on a very important agricultural soil type. Probably 75 per cent of the land in cultivation today in this country is steeper than two per cent. I suspect that half of the area now in cultivation is as steep as that from which the Missouri experiment showed an excess of 40 tons per acre pouring off bare land. The rates of washing usually are not so fast under the cultivated crops, but they are sufficiently rapid to show that the soil is being swept away at a rate which no business can withstand without serious impairment. For example, 49 tons per acre were lost as an average of 12 years under continuous corn at Columbia, Missouri, on Shelby loam.

Turning again to the findings of the Oklahoma survey, it is observed that of the approximately 16 million acres of cultivated land nearly 7½ million acres were classed as land affected by sheet erosion. A letter recently written to the Secretary of Agriculture by a very prominent educator connected with the University of Illinois contains the statment that:

> "Although Illinois is not ordinarily considered as being subject to erosion to the same extent as many other states, erosion is one of the really serious problems facing a large group of our farmers. While there are at least nine million acres of low value land in Illinois subject to serious erosion, more than one-half of which is hardly suitable for cultivated crops, there are more than 14 million acres of high value land in the State, subject to serious erosion, which is gradually approaching a stage where gullies are being formed."

There is no necessity in going further at this time to paint the seriousness of erosion. I think we all know about it, and I am convinced that it is a matter about which we are all gravely concerned. The question we are facing today is: what are we going to do about it? Certainly, we shall accomplish nothing by merely talking and pointing fingers of warning. We have made up our minds, very seriously and very earnestly, that this is one of the most serious problems confronting American Agriculture, and we have decided to make a vigorous attack against the evil. Our plans are by no means mature as yet; but the Department of Agriculture has set out to get at the bottom of this difficult situation, insofar as the facts and fundamental processes relating to the problem are concerned.

We have set out, also, to test the efficiency of various structures and different cropping systems, adjusted to the varying types of soils occupying different degrees of slopes, as instrumentalities of control. Six experiment stations have been located on representative soil types situated in broad soil regions, where erosion is a serious problem. These are located in Oklahoma, Kansas, Missouri, Texas and North Carolina. The oldest one is that at Guthrie, which we shall see tomorrow.

At these stations we are attempting to determine the precise rates at which soil and soil fertility are being lost on the different slopes occupied by the different soils, and also we are measuring the accompanying losses of water by runoff. These measurements will be scrutinized in the fullest necessary details to determine the relation of slope, rate of rainfall and crop and cultural treatment to erosional processes. Although these researches have only recently been inaugurated, we are already deriving from them some valuable results. We have found, for example, that the productivity of soil is not only profoundly diminished by erosion, but we are finding evidence that the quality of the crops produced on eroded lands goes down with the yields. We have found at the Temple Station that the chalky subsoil underlying the very important Houston black clay soil is not nearly so erosive on certain slopes as the black topsoil; yet, when this material is too abundantly mixed with other soil material in the terrace composition, such places may represent particularly vulnerable spots in the terrace—places where breaks may occur under trying conditions of excessive rainfall. We have learned, also, that the absorptive capacity of this kind of material is greater than that of the black soil covering it and this fact, together with other indications pointed to by the test thus far made, undoubtedly has a very important relation to highway construction, since it indicates that chalky material of this kind probably constitutes far better subgrade material than the black topsoil.

We are testing at all of these stations the efficiency of terraces of various types of construction of varying grade for the different slopes. I shall not go into the details of these studies at this time in view of the fact that we shall see what is being done in this connection during our trip over the Guthrie Station tomorrow. Undoubtedly others will have something to say about these matters in the course of the discussions to follow here during the progress of the conference.

We are going also to try out a large number of cropping schemes in order to learn what part these may have in the matter of erosion control throughout the various regions. We propose to find out by experimentation how far it is possible to go in a practical way in the matter of controlling erosion on increasing slopes. From the results of these investigations it should be possible to determine for the different soil types just where the growing of clean-cultivated crops and of grain crops should stop, due to excessive erosion and inability to control it in a practical way. On the other hand, such information should show at what degree of slope we should begin to use the land for permanent grass or for forestry.

We will not be able to solve all these problems at once. I want to express my earnest belief that it is going to take the most diligent and searching efforts of a large number of specialists, cooperating in the most effective manner, to carry through this undertaking of trying to slow down one of the most vicious agencies of soil decline that mankind knows anything about. Not only unstinted efforts and sustained cooperation will be required of us, but we must have the full time and best efforts of determined men who will not be satisfied by anything short of success. Probably we shall make mistakes from time to time and probably, also, the heavens will break loose occasionally to discharge upon our structures rainfall in destructive and dismaying quantities. We must not falter, however, in the face of any such obstacles.

A word about the relation of erosion to American agriculture might be appropriate at this point. Bad as erosion is, we do not fear that the Nation is standing upon the brink of a disastrous land shortage. Undoubtedly, we have enough land to produce the necessary food and clothing for our increasing population for a considerable number of years hence. On the other hand, we ARE getting much nearer to a shortage of GOOD LAND than most of us have supposed. Many thousands of farmers today are operating on enfeebled land which is too poor to yield profitable returns, even when prices are good, and to these farmers relief from erosion constitutes their real farm problem. Many of these are barely eking out an existence. Held to their lean acres by reason of the fact that they know of no other place to go, I have the feeling that these hard-working farmers are not getting an even break of opportunity, solely because of their unproductive, severely washed sloping fields. With these, the seriousness of erosion is not a threat of the future, it is a present and pressing problem.

In connection with our research investigations, I have the feeling that we should, as soon as possible, carry through a considerable number of erosion surveys covering critical areas throughout the country. I believe that surveys of this nature will bring to light much information that is sorely needed in order to reveal to the people of this country the full seriousness of this process of land wastage. There is no question, whatever, but that the problem is not yet understood by the great masses of people with sufficient clearness for the Nation to stand back of our program in a determined and helpful way. I feel that the National Government, the states, the farmers, bankers, merchants, railroad people, implement manufacturers and others should earnestly and actively support this program of research. We want to get it clearly established in the minds of people generally that we are not dealing with one of nature's normal processes but want them to understand that the erosion we have in mind is largely a man-created process, one which throws all of nature's stabilizing agencies out of adjustment. The results do not stop merely at impoverishing our agricultural and grazing lands. We have in the wake of widespread erosion buried valley lands, highways and culverts; filled-up stream channels and irrigation ditches; grave silting of costly reservoirs and obstruction of harbors; and along with it all, increased frequency and destructiveness of floods.

According to the program being worked out by the Federal Department of Agriculture all available information in regard to soil erosion and water conservation will be collected and with the results of the researches at the laboratories and erosion stations, will be disseminated to the public through the Office of Extension, the State extension forces, the Office of Information, and by addresses before different bodies. The endeavor will be to arouse interest in the program and to make the results of the work immediately available to as many farmers and other interested persons as possible.

Research and extension work will, wherever possible, be carried on in cooperation with agricultural colleges, and state and other agencies, and an endedavor will be made to so coordinate the work in progress that unnecessary duplication will be avoided.

I wish to take advantage of this opportunity to congratulate the officers, the scientific staff and Extension Service of your State Experiment Stations and Agricultural Colleges for the interest they have taken in the development of this program and the members of your several State Legislatures who have shown their practical interest in the work by providing funds which will enable your State institution to cooperate with the Federal Government in this important undertaking which is of such vital importance, not only to those of you who are now on the land but to future generations of both producers and consumers of the products of the soil.

C. P. BLACKWELL:

We appreciate this contribution from Dr. McCall. Some of the other men who have taken the most interest in this erosion work are the people from Texas. The first work started in this state was at Spur by Mr. R. E. Dickson. Mr. Dickson has made one of the most valuable contributions that has been made in the southwest. At this time we will hear from Mr. Dickson relative to his work at Spur, Texas.

EXPERIMENTAL WORK ON SOIL EROSION AND WATER CONTROL IN TEXAS

By

R. E. DICKSON, Superintendent

Spur Experiment Station

In discussing the soil erosion and water conservation studies being made by the Texas Station I will confine my remarks to that portion of the work that is being conducted at the Spur Station and its application to the Western portion of the state. In order to place the emphasis where it belongs, as we see it, it is necessary to turn the subject, as assigned, around and discuss it from the standpoint of water conservation and soil erosion. Water is truly the first limiting factor in crop production throughout much of the Southwest.

We are in the fifth year with the studies at Spur. As the first three years' work has been reported in Texas Station Bulletin No. 411 these results will not be reviewed here. Crops were destroyed by hail in June and again in September of the fourth year of the experiment.

The question of the slope to be given along the terrace has probably been definitely settled for our part of the country for all time to come. The merits of the level terrace were proved with the first rains that fell following the completion of a system of terraces on the field areas. Each succeeding rain has confirmed the tentative conclusions. The Station was only a half a jump ahead of the farmers, or possibly a half a jump behind, in deciding on the level terrace. At any rate all of the terraces throughout the region are being constructed on the level and all rows are contoured. The correctness of this procedure is not questioned any longer in West Texas.

During the past four years the entire rainfall has been conserved on a 10-acre field area without causing bad results to a growing crop of cotton. The impounding of this rain water has been accomplished by the construction of ordinary level terraces with the ends closed. The results have been so outstanding, more especially in materially increased crop yields, that a check on the accuracy of the work is being made this year. Six well-equipped 10-acre field areas have been added to the original 10-field areas and should enable the drawing of some rather definite conclusions.

Another phase of the work that is causing no little worry is the utilization of storm waters from other areas. The conservation of the entire rainfall, so far, has been a very simple matter. The checking, distribution and finally the infiltration of storm waters that come down from denuded pasture lands with a large head is a much more difficult problem. Yet, our farmers are demanding that this problem be solved for them. Throughout the country they are damming up the bar-ditches along the highways and diverting the water onto their cultivated fields and are wanting to know how to distribute this water evenly over their hillsides and valleys.

We have been partially successful in catching storm water above level terraces, carrying it along the terrace for several hundred yards until it has lost its velocity, and then spilling it over a low broad terrace for several hundreds yards and finally catch the water again above the terrace below, divert it in the opposite direction and spill it again. This method of terrace construction has been termed the "Spread and Spill system" and while not yet perfect is a decided improvement over the graded or level terrace. We have just completed a system of terraces on the "Syrup pan" "Spread and Spill type" that have not been tested but we have hopes that they will show some improvement over other types that have been constructed.

The laborious and not completely satisfactory method of soil moisture determination employing the soil auger and drying oven is not practical or advisable in the study of runoff from small control plats. The method of arriving at moisture content in the control plat by auger sampling at desired depths in other plats designed to reproduce the condition of the control plats could not give accurate measurements of soil moisture in the control plats nor even reliable relative moisture percentages. Soil disturbances within the control plats must be reduced to the minimum.

Though the electric resistance method of moisture determination is generally not considered sufficiently accurate or satisfactory, it probably offers in this case the most nearly satisfactory method of moisture determination. Previous works on soil moisture measurements by electric resistance methods have indicated that one of the largest sources of error is in the contact resistance between the electrodes and soil. A rather comprehensive system of checking the contacts between electrodes and soil is being employed in an effort to remove this source of error. Undoubtedly this factor is of great import in affecting accuracy of results, probably its influence is as great or greater than variations of soluble salt content in the soil, and for measurement of relative moisture content of particular areas over a period of time, the elimination of this source of error would enable astisfactory determinations.

The resistance of the soil between electrodes is determined by an alternating current bridge. Bridge balance is observed by minimum sound in the telephone receivers. The frequency of the current source, a microphone hummer, is one thousand cycles which is high enough to prevent polarization of the electrodes. The results are recorded from day to day and plotted to form a curve relating conductivity and moisture content. The type of equation necessary to fit the curve is then determined from which may be computed the moisture content of the soil corresponding to other measured resistances.

If the electric resistance method of soil moisture determination is as accurate as it now appears to be at Spur it will be the equivalent, figuratively speaking, of turning the X-ray on the control plats.

DR. E. B. REYNOLDS, Chief, Division of Agronomy
Texas Experiment Station:

I am glad to hear of work done by experiment stations other than work done by our experiment station. We have planned to abandon the whole planting system at our field stations and revise them into a terraced system on which we have a fall of about 3 or 4 inches to 100 feet.

GEO. W. MUSGRAVE, in charge U. S. Runoff Station at
Temple, Texas:

Our program at Temple is a part of this national program and to that extent we are developing its various phases. There is one phase of our work that is of special interest to me and that is our endeavor to revise

methods and if possible trace completely the various forms of water in the soil. We think we have made some progress in measuring the evaporation of water in undisturbed soil and measuring percolation with the idea not entirely of getting those figures but in an endeavor to check through and balance our books on the moisture. When we have measured our runoff, percolation and evaporation then we can balance our books so far as the total rainfall is concerned. With that we hope we can arrive at the transpiration figure for some of the crops.

EXPERIMENTAL WORK IN TEXAS

By
ROBERT A. NORTON, Temple, Texas

I just want to take a few minutes to tell about some work that has been carried on by the Bureau of Public Roads at the Temple, Texas, Station. This work was started in April, 1929 and it is a cooperating project between the Bureau of Chemistry and Soils, the Bureau of Public Roads, and the Texas Experiment Station. The farm consists of about 140 acres situated about 4½ miles south of Temple. This farm is completely clear and is tillable throughout except for about six or seven acres where a little stream goes through. The soil is of typical Houston series, consisting of Houston clay and Houston black clay. About nine lines of terraces have been constructed. I want to point out briefly the type of experiments that are being carried on:

(1) There is an area on which three terraces have been constructed in which everything is held as nearly constant as possible, except the vertical spacing between terraces. The idea of that experiment is to determine the best spacing and the effects of steep slopes in that location.

(2) Everything is held constant except the cropping system.

(3) Everything is held as nearly constant as possible except the slope. Of the five terraces, two are built on constant grade and two are built on gradual grade. We are trying to determine how long it is possible to build terraces to advantage.

All of Field A is given over to experiments of level terraces on which the fall of the terraces is very slight. It is desirable to see how feasible these terraces with low slopes are.

The costs have been kept on the construction of all the terraces on the farm. We compare the use of different kinds of machines. An attempt is being made to determine more satisfactory methods for outlet and protection. We use home built and patent devices. We also take measurements at points six inches apart on the land to determine how fast the soil moves down the slope of the terrace. We have a number of plots on which unterraced experiments are being carried on with plowing—some with deep plowing and some with shallow plowing.

A number of level terraces are being constructed with both ends closed and with clay tile to carry away the water so that no soil will be lost. During the last of May we had a very heavy rain of about 5.4 inches in approximately four hours. On that farm there are 56 terraces (counting two terraces where some of them are very long, and the water runs two directions), and during that rain there were only six breaks in the terraces. All of those which broke had been constructed last February and had only had about four months to settle and become compact. I believe I am safe in saying that none of those terraces would have broken if they had had only the water that they were expected to carry. Practically all of the breaks occurred where a gully had been and even though the terraces had been built up three or four feet higher they could not carry it. The

silt that was poured out did not go off of the land, but was left right on the land in the holes which were made when the holes were washed in the terraces. To date no valuable records have been lost. We feel that we can take care of any further rains of such magnitude.

EXPERIMENTAL WORK IN KANSAS

By

F. L. DULEY, Kansas Experiment Station

I shall attempt to outline some of the work we are doing in Kansas, but I will dwell mainly, not on the experimental work, but rather on some of the problems which we have in Kansas. Erosion is a great factor in soil fertility in many parts of Kansas. The reasons for this are largely due to the varying climatic conditions which we have. I might say that we have two kinds of erosion in Kansas. We have wind erosion and water erosion. Now, from the standpoint of water erosion, I want to point out the variation which we have in our rainfall. It may be that our erosion is due to the rainfall conditions in Kansas which vary from 42 inches annually in the southeastern part of the state to 35, 30, 25 and 20 in other parts. In the western part, we have about 10 inches of rainfall. The result is that we get a tremendous amount of erosion from our rainfall because Kansas rainfall is characteristic of rainfall of the southwest which comes, not in gentle showers, but in terrific downpours on various occasions. I was very much interested in the statements made this morning about the Oklahoma survey where they have checked out quite accurately, I think, the amount of soil erosion which is actually taking place in Oklahoma. We have made no such survey as this in Kansas but we have made the next best thing and have made some estimates as to the amount of erosion which takes place. The erosion which is going on in Kansas depends very largely in many cases not only upon rainfall and type of soil but type of farming which we have. I was pleased to note in two or three talks that some of the men made reference to special crops to prevent erosion. It is my feeling that this is where erosion control should begin. We have actual figures for the land and crops for various parts of the state and we have estimated the amount of land which is eroded rather seriously. In the northeastern part of Kansas we have the corn belt, eight million acres of land of which four and one-half million are in cultivated crops. Most of the land in that part of the state is glacial country but in the western section there is a great deal of wind laid material much of which is eroding at a very rapid rate. We have estimated that about 75% of the total cultivated area in that section is being seriously eroded, some of it much more seriously than others. I want to point out one of the reasons for erosion in our state is the type of farming which we have. Most of that land was originally fertile. A great deal of that land has been cropped to corn most of the time since it has been broken. The lister has been used a great deal. There has been little attention given to the slope. Lister furrows go with the slopes and across the slopes.

In order to prevent the soil from washing out in the corn, ditches are cut across the slope so that they will take the water away down the slope cutting various cross-gullies as they go down. That method keeps the corn from washing out. This practice causes very serious damage and causes new gullies in the field all the time. We are probably losing more fertility in that section of the state than from any other part. In the southeastern section of the state we have our region of heaviest rainfall but erosion is less due to the fact that it is a mixed farming region. The land is derived from shale and is rather level in topography. We have estimated that, of the total land in cultivation, 40% in that section is being seriously

eroded. The next area was formerly called the foothill section. It is now called the blue stem region of Kansas. In that section we have a small percentage of land in cultivation and of this land in cultivation we estimate that about 60% of it is being badly eroded. The next area is what we call the eastern wheat belt which comprises 16 million acres with about 10 million acres in cultivation. We have estimated that about 30% of the land is being eroded to the extent that good farms are being given attention. The severity of this erosion is much less. A great deal of the land is in wheat. Many sod crops are present. We have the western wheat belt of about 14 million acres. Five million acres of this land is in cultivation. About 25% of that is eroded very seriously. The seriousness of the erosion is probably much less than in the eastern section. In the western plains area probably 10% of that land is seriously eroded. A summary we made of the state shows that there is about 52,000,000 acres of land with about 24,000,000 acres in cultivated crops and probably of this amount there is approximately 10,000,000 acres being eroded sufficiently to justify special precaution. This would represent about 41% of the cultivated area of the state. I have tried to indicate the relative seriousness of the erosion in the different parts of the state. The northeastern section is eroding much more rapidly than in the other parts of the state. In this section although the percentage is high, the total is relatively low.

I might say just a word about the investigation work which is being done. Of course, the principal experimental work being done is being done at the Hays Station. Since that will be discussed by other men present, I shall take no time to discuss that project. At the Hays Station we have had established some level terraces on which we are trying to hold all the water on the land and so far those have given fairly satisfactory results. This is simply from observation and not from actual measurements on it. The same can be said for the work at Manhattan. We have been trying out the different types of terraces. We have been, for a number of years, using different types of terraces. We have even some level terraces on the soils at Manhattan and although our subsoils are much tighter and our rainfall somewhat higher than we would assume would be good conditions for level terraces, yet they have already worked better than we thought. These terraces, however, have the ends open and do not hold all the water on the land. We are also trying out different types of terraces with broad and narrow ridges and different methods of cultivation on these terraced fields and different methods of maintaining these terraces and also different methods of stopping ditches. Most of this work is observation.

One other thing we are considering is the losses from horticulture lands and the terracing of orchards. We have a section where a large per cent of the steepest land is in cultivated orchards. Our Horticulture Department at Manhattan has just this spring put out a five-acre cherry orchard on terraced lands. The terraces so far seem to be working pretty well. I do not want to talk too much about the wind in Kansas because we already have a bad reputation. It seems that the report got out earlier and too many people have the wrong impression about Kansas winds, but there is a limited damage coming from this cause. A number of years ago some of the early settlers in northwestern Kansas were on the verge of getting out because some of the land was being actually blown away by the wind and they seemed unable to stop the damage. Some work was started at the Colby Station in which various methods were tried. A number of methods were devised whereby wind erosion is being much better controlled at the present time than it was formerly. The danger, however, is always with us and the farmers in the western part of the state are always thinking about whether or not their soil is going to blow. It is an annual proposition. It is a major point and must be constantly guarded against or we would undoubtedly have far more corn losses than we are having at the present time.

I feel that we certainly need additional work on erosion control in Kansas. We need to expand our work on some of the other soil types which are very erosive. We hope to do this as soon as possible but the work which is being done is helping out a great deal. We hope to get a lot of information from the experiment fields which are established in those places.

One other thing I wanted to mention is water conservation. This has been very well presented here by Mr. Dickson. We have an area in western Kansas, probably six million acres of cropping land, where it would be extremely desirable to increase the amount of available water if there is any possible way of doing it. We have various tillage methods by which this problem is being handled to a great extent. Just how much can be accomplished in increasing our available water is a matter of speculation. The only information we have on this in bulletin form are observations and measurements made by the engineers and geologists whereby they are measuring the amount of water which is being lost through our streams. When those measurements are considered, they would indicate that for the most part we are losing a relatively small per cent of our rainfall by runoff from our western lands. Just how much we are losing, of course we are not prepared to say but the measurements of the level flow would lead us to think that the possibilities are somewhat limited as to just how much can be done in the way of saving water. Any amount which is saved, of course, is an addition to the available supply and that is really the thing that counts.

Another point which was made this morning is the amount of percolation. Where does the water go? We are inclined to think that in most of the soils in Kansas there is practically no percolation. Most of the losses are due to runoff and evaporation and transpiration. Our measurements, taken over the past 20 years, would indicate that our subsoils in that section of the state are almost perennially dry and we do not get water actually through percolation. We are very much interested in this erosion problem in Kansas. We feel that it is one of the biggest problems with which we have to deal. We are getting some very valuable information and soon hope to get ahead with it. We are very glad to have the experiment station at Hays which we hope will give us additional information of great value which we can apply to many parts of the state.

EXPERIMENTAL WORK AT HAYS, KANSAS

By
RAYMOND R. DRAKE, Hays Station

The Hays Farm was started September, 1929, and is similar to the farms at Guthrie and Temple, Texas. The farm contains approximately 220 acres. The lower conditions are more like the Texas Station. The soil is Colby Silty loam soil, with 150 acres level. The main thing on this farm we are stressing is the level terraces for soil and water conservation. On the graded terraces we are going to have different tillage methods. We are going to have rotation of crops in the graded terraces to determine just how much grading is effective. Those slopes will be about 4% to 10%. The peat loam is all level terraces with no graded terraces. The terraces will be 20, 30 to 45 feet. Wheat land is on level terraces and there are no graded terraces. The height of the terraces is from 9 to 15 inches. Terraces are built in different widths. We must devise a terrace over which heavy machinery can be used. All the steep slopes we are going to sow to kafir. Just how much of a slope we can use, we are going to find out.

R. H. DAVIS of Hays Station.

It has been pointed out that the Hays Station is somewhat like that of Spur in the matter of water conservation coming first and erosion second. At Hays we have a rainfall of approximately 16 inches. Evaporation is 25%. The question of water conservation is primarily important. We have had some rather interesting results from a few rains we have had this spring. The total rainfall is 2.8 inches. On the small control plots, we had all the way from no runoff to 13%. Only 1.2 inches came with any intensity. Last Saturday night we had a rain of 0.95 inches. We had all the way from no runoff to 35%. It is probable that we are losing a great amount of water under certain conditions. The Colby Silty clay loam erodes easily but has enough clay in the soil to give the soil the ability of holding together better. Another phase of the work we started is the possibility of growing legumes such as alfalfa and sweet clover. We are trying to conserve all the moisture by terracing. The effects of the water on different types of terraces and moisture on different types of tillage methods are considered.

SOIL EROSION IN WESTERN MISSISSIPPI

By
G. H. LENTZ, Silviculturist
Southern Forest Experiment Station

At the first session of the Southwest Conference on Soil and Water Conservation held at College Station, Texas in June, 1929, a program for soil erosion, moisture conservation and stream flow regulation, provided for by the 1930 Agriculture Appropriation Bill, was reported upon by Dr. A. G. McCall. Of the $160,000 included in this appropriation, the sum of $10,000 was allotted to the Southern Forest Experiment Station of the U. S. Forest Service, to conduct studies on erosion and erosion control in the lower Mississippi Valley. The project was described in the first report of the Committee on Soil Erosion, March 25, 1929, as follows:

"The area of most serious erosion in the lower Mississippi Valley as disclosed by the recent survey occurs in a loose formation east of the Mississippi and south of the Ohio rivers, an area roughly 500 miles long and 50 to 75 miles wide as a maximum. This area is one of the heaviest contributors to the silt problem of the lower Mississippi. The rapid destruction of cultivated lands is an important factor in farm abandonment, and the only remedy seems to be through the restoration of forests. The work proposed is research on forest restoration designed to meet the local conditions. It will be handled by the Southern Forest Experiment Station. Cooperation with State and other agencies will be arranged if feasible." (1).

Three men have been assigned to the erosion study at the Southern Station; the speaker being in charge of the project, assisted by Assistant Forest Ecologist J. D. Sinclair and Junior Forester H. G. Meginnis. Active field work began in November, 1929. The work to date has been in the nature of an extensive survey of the western portion of Mississippi. Six separate counties have been studied in some detail and general observations have been made in 10 or 12 others. The six counties, Marshall and Lafayette in the northern part of the State, Carroll in the central portion and Wilkinson, Adams and Jefferson counties in sonthwestern Mississippi all lie within the boundaries of the Silt Loam Uplands.

These uplands border the alluvial lands of the Mississippi River bottomland on the west, while on the east they are bounded by varying geological soil formations of marine origin. The principal soil formation in the Silt Loam Upland is a brown loam or loess which covers practically all of the western portion of each of the counties mentioned. This loessial material, which is undoubtedly a wind blown deposit, mantles the surface, having its greatest depth along the western border where it meets the bottomlands and gradually thins out toward the east, finally giving place to the Coastal Plain soil formations. Unweathered loess is confined to the western portion of the Silt Loam Upland region. Geologists differ in their opinion concerning the exact origin of the wind blown material but it is generally supposed to have been derived from powdered rock formed by glacial action and carried by prevailing westerly winds to its present location. The following description appears in Ground Water Resources of Mississippi, U. S. G. S. Water Supply Paper 576: (2). "The typical loess is a grayish to yellowish to brown massive, calcareous silt, the fine particles of which consist chiefly of calcite, dolomite, feldspar and magnetite. The material is relatively light and porous and permits water to percolate down through it readily. Shells of snails are scattered through the loess and in places are abundant."

Upon being exposed to weathering, the loess loses its characteristic composition and breaks down into a fine silt loam of which the Memphis silt loam is the type most frequently found in Mississippi. The silt loam may gradually merge into the underlying unweathered loess or if weathering has progressed far enough and if the original loess layer was quite thin, the silt loam may lie directly over sand and clay.

The thickest deposits of unweathered loess occur in Wilkinson and Adams counties in the southwestern part of the State where this layer may reach a depth of 75 to 80 feet. The bluffs at Natchez, Fort Adams, Rodney and at Vicksburg are of loess and at these points the transition from Bluff to Delta is very pronounced. In the northern portion of the State there may be no sharp break in the topography where the loess uplands gradually merge into the bottomland. In Wilkinson and Adams counties the loess and the Memphis silt loams of loessial origin give way in the east to a formation known as the Citronelle. In Marshall and Lafayette counties the Wilcox formation borders the eastern edge of the silt loam area and in Carroll county the loess and silt loam are bounded on the east by the Lisbon formation. Sands and clays are the principal soil materials in each of these latter formations. The loess and silt loams lie at a higher elevation than any other soil in western Mississippi and the region where they are found is often termed the Loess and Silt Loam Uplands or simply the Silt Loam Uplands. The topography of the Silt Loam Uplands varies from gently rolling to rough hilly country, cut by numerous deep ravines with knife-edged ridges separating the ravines. Bluffs of silt loam and loess are found at the western edge of the Uplands while at the eastern edge the loess disappears and the silt loam in turn thins out and gradually merges with the sands and clays of the Coastal Plain formations so that it is often difficult to tell where one soil province ends and another begins.

According to Dunbar Rowland, State Historian (3) the western portion of Mississippi was settled between 1800 and 1840. Farming has always been the chief industry although many areas once farmed have reverted to waste and forest land. Many lands cultivated prior to 1860 have been abandoned and the origin of numerous old field pine stands can often be traced back to the Civil War period. The chief crop is cotton and very few changes have been made in methods of cultivation since early Colonial days. Hills are still being cleared, farmed and abandoned; few attempts are made to hold the soil except where contour plowing is practiced. It is estimated that 75 per cent or more of the farm lands are farmed by tenant farmers and the average farm is about 85 acres in size.

For the counties studied, there was a decided decrease in amount of land in cultivation between 1910 and 1925. Based on the area for 1910, there was a decrease in the amount of land in farms of 10 per cent between that time and 1925, according to the U. S. Census of Agriculture. (4).

The Silt Loam Uplands form an area of approximately 9,000,000 acres, or more than ¼ of the entire area of the state of Mississippi. It is estimated that 50 per cent of the land area in the region has a forest cover, 18 per cent is being farmed, 22 per cent is in pasture and 10 per cent is waste or unclassified land. These estimates are based partly on census data and partly on observation in the field. H. H. Bennett makes the following statement concerning this area:

"In the 'brown loam' belt skirting the Mississippi bottoms on the east side, county after county includes 10,000, 20,000, or 30,000 acres of land which have been ruined by erosion. Agriculture has been driven out of a very large part of the upland of several counties in northwestern Mississippi by the gullied condition of the upland. Hundreds of farms in these and many other counties of the region have been abandoned to timber and brush." (5).

Our preliminary studies have been made with the idea of obtaining a better basis for an attack on the erosion problem; to find out where the most serious erosion has been taking place, what has caused it to start and how fast it is progressing, as well as to ascertain what control steps have been taken and their effectiveness. It was also desired to see what effect forest cover has in preventing erosion or in helping to stop gullies once they have started. Each of six counties has been covered as thoroughly as possible with the time available. Interviews were arranged with numerous land owners, local county officials, state officials and others in order to obtain information to supplement our own observations. The county agricultural agents and local tax assessors have supplied valuable information and have shown a willingness to cooperate. Some of the better informed men evidently realize that valuable farm land is being lost by erosion, but in very few cases have attempts been made to control soil losses. In spite of the excellent work done by the Extension Department of the Mississippi A. and M. College and the fine example set by the Holly Springs Experiment Station, well terraced lands are rarely seen in this region, even though the most ignorant negro tenant seems to realize the need for contour plowing, which he usually practices, especially on steep slopes. J. T. Copeland in Extension Bulletin No. 34 "Terracing in Mississippi" (6) gives full details for building terraces.

In some quarters there has been a general belief that the worst erosion in the silt loam upland has occurred and is still taking place where the loess is conspicuous. It is true that where the silt loam is underlain by unweathered loess some erosion has taken place, but the soil erosion problem was found to be much more serious in the areas lying to the east of the loess formation. The sands and clay of the Citronelle and Wilcox formations seem to erode much more rapidly than do any of the silt loams. Where a layer of silt loam or loess overlies beds of sand and clay, it breaks off in large masses when subjected to undercutting even though the breaks may be along vertical lines. Once such erosion has begun, its advance is usually rapid. In Wilkinson and Adams counties where the deepest silt loam and unweathered loess were found, the erosion problem has not assumed such serious proportions as it has in Lafayette and Marshall counties where the mantle of silt loam and loess is comparatively thin.

Three separate types or stages of erosion have been recognized in our study, namely: Sheet erosion, gullies, and breaks. These types have been defined as follows:

Sheet Erosion—where the soil is washing off from a generally smooth surface and where the cutting into the soil has not progressed to a depth of more than three feet.

Gully—where the erosion is well advanced and the surface is deeply cut into but where the sides of the cuts still have a V-shape and are not over 10 feet in depth.

Breaks—where the soil has washed to such an extent that the cuts are more than 10 feet deep, with vertical walls beginning to form and the soil sloughing off in large masses. A break usually represents a system of gullies in which erosion has progressed to the point where intervening areas between gullies have been largely removed, leaving widened washes with vertical walls.

In the counties referred to, we traversed all the passable roads and took notes on the conditions of erosion found. The three stages of erosion were noted down according to the surface area eroded and a percentage figure for each county was derived. Only the areas where mineral soil was exposed were considered at this time and these were classed as actively eroding. We obtained the following results:

Counties	Per cent of cleared land surface actively eroding
Marshall	8.3
Lafayette	6.0
Carroll	4.4
Jefferson East ½	1.5
Jefferson West ½	.5
Adams	.3
Wilkinson	.8

These figures are rough estimates at best, but for purposes of comparison they will suffice, and the comparison between the northern counties, Marshall and Lafayette, with the southern counties is very striking. But these figures do not tell the whole story. In the northern counties the breaks and gullies are deeper as well as more numerous than in the southern counties. Erosion seems to be advancing at a much more rapid rate in Marshall and Lafayette counties than in the others. Not only are the breaks and gullies deeper in these northern Mississippi counties, but fewer examples were seen there of erosion being checkd by grass, shrubs or trees. In Wilkinson county in particular we found old gullies and breaks partially controlled by vegetation. Many areas had seeded in to loblolly pine.

The mean annual rainfall is about the same in each of the counties mentioned—between 50 and 60 inches per year. Therefore, the wide difference in amount of erosion between the various counties cannot be attributed to variations in rainfall. We believe the difference can be accounted for by one or more of the following factors: differences in temperature; differences in vegetation; variations in depth of loess or underlying strata; past farming practices.

In most cases it is difficult or impossible to obtain the complete history of any particular gully or break. The areas of most serious erosion have been active for so many years that even the oldest inhabitants cannot remember when erosion began. Dr. E. N. Lowe (7) State Geologist of Mississippi, and a recognized authority on erosion conditions, called our attention to Linders' pasture on the outskirts of Oxford in Lafayette county. He knew this area to be good pasture land in 1884. Now it is dissected by two large ravines and numerous breaks. Most of the original surface has disappeared and thousands of tons of silt, sand and clay have been washed out and have either been deposited on the level bottomlands or have found their way into streams. The side walls of the breaks are vertical for the first eight to sixteen feet, grading off to a slope of 50 to 60 per cent. The upper stratum is silt loam lying over stratified layers of sand and clay. It is not known just how fast the heads of the breaks are working back into the small amount of pasture which remains, but between November, 1929, and February, 1930, a decided change was noticed, large chunks of earth having broken away from the vertical side walls. The only portion of the area that is not eroding is that protected by a forest cover. The rest is a labyrinth of gullies, narrow gorges, steep buttes and pinnacles.

A few miles north of Carrolton, in Carroll county (on Jim Mayberry's farm) we found an area that has been actively eroding for about 25 years. A farmer 30 years old remembers when the area was in cultivation. Now it is a treacherous hole with precipitous sides, 30 to 40 feet from the ends of the cotton rows. This hole covers an area of two to three acres of land which is now made up of sterile sands and clay that have assumed weird and grotesque shapes. The various strata have different shades of coloring ranging from white to light pink to salmon red and the effect reminds one of the picturesque Garden of the Gods.

West of Fayette, in Jefferson county, an area of 12 acres was thrown out of cultivation in 1920. Prior to 1910 this portion of a 160-acre farm was covered with an excellent stand of shortleaf pine. In that year the timber was cut, the land was cleared and cotton planted. The soil was sandy loam two to four feet deep and the slopes were from 10 to 15 per cent. Sheet erosion started as soon as the soil was exposed and in a few years gullies started to form. By 1920 the field was thrown out due to the fact that the gullies had cut the area into blocks too small to be profitably cultivated. Sheet erosion had carried away most of the fertile top soil. When we visited the field last March it was completely ruined. Gullies 10 to 12 feet deep were cut across the old furrows and many of the furrows had been cut down four to five feet leaving a high ridge where the top of the furrows had been. Fifteen to twenty per cent of the original surface had disappeared. Here a 20-year cycle had occurred from forest to farm to waste land.

Ford's Pond, six miles south of Holly Springs, Marshall county, and about ½ mile to the west of the State road is probably the deepest and largest single gully in western Mississippi. It is approximately 2000 feet long, 300 feet wide and 100 feet deep. For the first 40 feet the walls are almost perpendicular; the upper six to eight feet of soil is a brown loam underlain by sand and clay. Beginning at the 40 foot level the slope ranges from 15° to 60° and the soil is made up of the material that has sloughed off above. At about the 70 to 80 foot level a layer of lignite and lignitic clay is exposed and under this is a layer of heavy clay. No one seems to know how long this ravine has been in existence but it is heading back into the adjoining cotton land at a rapid rate. The advance in the last two years as indicated by the old furrows has been about 25 feet per year. From the time of its origin to the present time it is estimated that over two million tons of material have been carried out of this ravine. Some of this material has been deposited as an outwash plain, some has filled the stream beds full of sand and the lighter and finer particles have been carried down the Tallahatchie to the Yazoo and finally into the Mississippi river. Many of the streams in Lafayette and Marshall counties have their channels so filled with sand that any water simply overflows the banks.

These examples are not exceptional ones and many more of a similar nature could be described. The area actively eroding seems to be materially augmented each succeeding year.

In spite of the fact that it is impossible to get the full history of most of the eroded areas it is not difficult to trace the origin of most serious erosion to human activities in one form or another. No serious erosion is taking place where man has not cleared the slopes for agriculture. A forest cover of any sort seems to hold the soil in place even on the steepest slopes, whereas two or three years of improper cultivation on a hillside may bring about its complete ruination with attendant damage to other farm land on which the washed material may be deposited.

Some of the factors hastening the rate with which erosion is ruining good hill land are:

1. Overgrazing on restricted areas.
2. Repeated fires in grass and brush lands.
3. Use of improper methods of cultivation (farming slopes too steep to be profitable; lack of suitable terraces).
4. Absentee ownership (the system of farming on shares).
5. One crop farming.
6. System of taxation on standing timber.
7. Improper road drainage.

Each of the above points will be discussed briefly.

Overgrazing—Where cattle, horses or sheep are concentrated on restricted areas such as in a fenced pasture, or where certain paths are continually used to reach salt licks or water holes, the grass covering may soon be worn through exposing the mineral soil beneath. The exposed soil soon starts to wash so that a gully forms and its progress is further hastened by constant trampling. The frequent occurrence of badly eroded areas in close promixity to farm buildings is quite noticeable in the hilly portions of Mississippi and can be directly traced to the action of livestock. Even in more extensive pastures where steep slopes occur, the cutting of the sod by the sharp hoofs of cattle and sheep may also bring about serious erosion.

Repeated Fires—It is estimated that woods fires burn over as much as 20 per cent of the land area in northern Mississippi every year. In southwestern Mississippi the hill lands in the bluffs region are covered to a large extent by hardwood stands and fires are less frequent. Repeated fires kill or stunt the pine and hardwood reproduction that may be coming in on eroding lands. Grasses and sedges on abandoned fields are commonly burned over every year, exposing soil to the direct action of rain and preventing the building up of humus. Dr. W. C. Lowdermilk (8) in his erosion studies in California has shown that lack of a humus cover results in a more rapid run off and consequently more serious erosion. There is no doubt that repeated fires in Mississippi have had a direct bearing on the erosion problem.

Lack of Proper Methods of Cultivation—Throughout the hill section of western Mississippi, steep slopes are being worked. Cotton and corn have often been planted on steep slopes (40 to 50 per cent slope) without the use of terraces. The customary shallow plowing scarcely scrapes the surface of the ground and the run-off easily breaks through the shallow furrows. Lands too poor to produce more than two or three crops without fertilizer are thrown out and this fallow land erodes more quickly than does similar land when kept cultivated (shown by the work at Spur, Texas.) We have seen any number of areas in Mississippi abandoned after two or three crops have been grown and harvested. It has been noted that where the silt loam is deep and underlain by loess, very steep slopes can be cultivated with a minimum of damage, but this does not hold for lands lying outside of the loess area.

Absentee Ownership—A high percentage of the farms in Mississippi, as well as in other portions of the South, are owned by planters or merchants who reside in town. Most of the actual farming is done by negroes working on shares, and their crude methods of cultivation are responsible for much of the erosion. The owner often takes little or no interest in his land and his tenant cares even less. If the land becomes too badly washed to be productive, the tenant moves on to another area and the process is repeated.

We came across one of the land owners in Lafayette county who takes considerable pride in his upland farm. He had terraced a large portion of his land and was trying to keep the terraces in good condition. One of his negro tenants, however, abandoned the terraces on his particular tract and gullies soon ruined the field. When the negro tenant was taken to task for not keeping up the terraces he replied: "I'se paying rent for de land, not for terraces." Where intelligent and progressive farmers handle their lands by approved methods, the farms are seldom worn out and the land may even be improved.

One Crop Farming—For years cotton and corn have been the two crops most commonly grown in Mississippi, and crop rotation to build up the soil is seldom practiced. It is still a common sight to see cotton and corn stalks cut down and burned in the field rather than plowed under. No organic

material gets back into the soil when the cover is burned off, hence the soil loses its absorptive capacity, making it more subject to erosion. The county agricultural agents are advocating the growing of legumes and other cover crops and some progress has been made in that direction.

System of Taxation on Standing Timber—Several Mississippi counties have recently raised or are planning in the near future to raise assessments on standing timber. A survey is now being made in Jefferson county for the purpose—so we were told—of revaluing timber stands for taxation purposes. Even though the valuations on timber stands had not yet been raised, several stands of timber have already been cut rather than take the risk of higher taxes. In the county, with a tax rate of 45 to 50 mills, the tax problem as applied to standing timber is a serious one and this has a direct bearing on the soil erosion problem. As long as the land is in timber practically no soil erosion takes place, but once the soil is exposed by having the timber removed the erosion cycle begins.

Improper Road Drainage—The water from road side ditches is often diverted onto cultivated land where it causes deep gullies to form. The water in many cases is diverted to an adjoining farm without any further steps being taken to prevent washing. A large number of bad gullies and breaks in north Mississippi owe their origin to improper road drainage where a little care and foresight could have prevented such damage.

Although the soil erosion problem in northern and central Mississippi is very serious, very little is being done about it. The extension department of the A. and M. College and the agricultural experiment stations are convincing some of the farmers that terracing is necessary on erodible soils where slopes of 10 per cent or more exist. But no systematic control work has been attempted in the gullies, breaks and bad lands of the state and the condition of the eroding areas is rapidly getting worse. In the adjoining state of Tennessee, with somewhat similar conditions existing, an excellent piece of erosion control work over an extensive area is being carried on. In 1915, the State Forester, Mr. Rufus Maddox, (8) undertook his first work of gully control and the work has been continued and its scope has increased yearly. The results obtained by Mr. Maddox are worthy of study by every one interested in the problem of erosion control.

In the control methods worked out in western Tennessee the procedure has been as follows:

1. Brush dams two to three feet high are built at frequent intervals in the bottom of the gullies and breaks so that the back water from one dam will reach the base of the dam above it. These dams catch the silt, hold it in place and thus cause a series of terraces to be formed. Bermuda grass is then planted on the soil caught by the dam to help hold it in place.

2. A plow and "push billy" are used to loosen and push over the upper edges or rim of the steep sides of the gully. The soil on gully slopes is seldom suitable for any growth but the top soil which is pushed over or broken down provides soil for planting. Steep pinnacles and buttes are also partially leveled off. Steps one and two are usually taken in the fall or early winter when farm labor and teams are generally available.

3. The following spring, black locust is planted on every site where sufficient soil exists. One year old stock is used and the trees are set out about 5½ feet apart in rows following the contours. The uneroded land which cannot be profitably cultivated for farm crops is plowed, harrowed and also planted to black locust. To get the best results from black locust, it should be cut off at the root at time of planting. A sucker will then be sent up

which will be more vigorous than the original stem. Where it is possible, cultivation for the first year is desirable and results in increased growth by all the trees so treated.

4. Once established, the black locust will spread from root suckers. In 10 to 12 years fence posts can be cut from the stand. After such a cutting if the surface and the roots are broken by plowing, a dense stand of root suckers will come up and a new stand will be established. The locust is very effective in holding the soil in place and deep gullies have been reclaimed in this way. Areas so treated must be protected from grazing until the trees are above the reach of cattle. Fires must also be kept out.

Honeysuckle and the imported Kudzu vine have also been used to good advantage on some eroding areas where for one reason or another it was not desirable to plant locust.

In the erosion studies in Mississippi we plan to do more intensive work in several of the northern counties so that we may determine more accurately just what has taken place. We plan to select several areas of about 160 acres each, make contour and cover type maps showing all the eroded portions of the tract as well as the condition of the land. The boundaries of timberland, pasture land, cultivated land and land lying fallow will be shown. Each gully and break will be carefully located on the map and cross sections of the gullies and breaks will be taken at intervals. We can then calculate the amount of soil that has been carried away. By measuring the sand and clay deposits of the out-wash plains we can estimate what percentage of the removed material has been carried into the streams.

Following this work we expect to inaugurate studies in run-off and silt determination for various slopes and various types of cover. Small plots will be laid off and isolated by a frame of one inch boards so that no outside run-off may enter the plot. Silt traps will be constructed at the lower end of each plot so that the run-off of water and silt may be measured. Rain gauges will be set up at each plot and the per cent of run-off determined. A recording tipping bucket rain gauge at a central plot will measure the intensity of rainfall so that run-off and erosion can be correlated with the amount and rate of rainfall. It is planned to install three separate plots in each of the following cover types:

1. Forest.
2. Pasture land.
3. Cultivated land.
4. Fallow land.

Various methods of erosion control will be tried, using locust and other tree and brush species, particularly as a follow-up after the soil has become fixed. It is also planned to try out methods of building brush dams and of breaking down the steep banks of gullies and breaks, in cooperation with State agencies. It will also be possible to compare the run-off and soil loss from treated and untreated areas in order to bring out the effectiveness of control measures. The district agricultural agent in north Mississippi and the State extension forester plan to establish demonstration erosion control areas in five northern Mississippi counties in the fall of 1930 and we hope to cooperate with them.

Due to the size of the task involved, and the relation which soil erosion bears to streamflow and flood control, the problem is more than a local one. This relationship has been brought out by Mr. E. A. Sherman in his report on "The Relation of Forestry to the Control of Floods in the Mississippi Valley" (9). Under existing agricultural and economic conditions it seems highly improbable that the land owners, the counties or even the State will be able to carry on any extensive control measures in the near future. In

the meantime the forests are being depleted and trees are being deadened each year to provide new farm lands; fires burn unchecked over grass lands and forested areas; additional land is abandoned each year with consequent soil losses from erosion. A forest cover helps to protect the hills, checking erosion which has alrealy started. Under controlled methods seriously eroded land can probably be changed into a productive timber producing area, which will then prevent silt and sand from clogging up the streams and rivers.

Under the provisions of the Clarke-McNary Law the Secretary of Agriculture is authorized to recommend for purchase forested, cutover or denuded lands within the watersheds of navigable streams and to administer these areas as national forests. The National Forest Reservation Commission has recently approved a purchase unit in southwestern Mississippi along the watersheds of the Homochitto river. From an erosion and stream-flow control standpoint, the situation in northern Mississippi is far more critical than that in the Homochitto area. It would therefore seem very desirable that the Government establish a national forest area in the eroded section of northern Mississippi. Federal control and supervision can provide the necessary steps which will prevent further soil losses, will reclaim areas already badly washed and at the same time serve as an excellent example of methods of erosion control. The erosion studies of the Southern Forest Experiment Station should serve as a basis for future land management plans in the Silt Loam Uplands of western Mississippi.

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THERE CAN BE TOO LITTLE EROSION

By

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We have developed a very great interest in the whole matter of erosion and its control, especially, in the last few years, and this has been due, I think in our State at least, to two or three years of heavy rains when soil erosion was very bad. We have had some large rains which caused the soil to erode badly and everyone has noticed it. We have had a lot of land following the inflation and depression which has become marginal. Much of the land has become abandoned and is being badly gullied. Along the finest hillsides the land is being cut to pieces by gullies because the land is not being cultivated. Those gullies remain there for an indefinite period. There are not many but there are too many. The same thing is true in other states. People have begun to realize that it is a real erosion problem, and meetings like this show that not only the people in the individual states but the people of the entire country are becoming interested. It is very fitting, indeed, that special attention be given to this at this time.

The work in Missouri goes back to 1915. In 1915 I had a student who was assigned a special problem. We went out on a slope and took a little tract of land and put a little levee around it and at the lower part of it we let this levee empty into a tank. We wanted to see how much water ran off of it. We got some very interesting data from that test. That worked fairly well. The next year a graduate student took two plots of ground about six feet wide and about 80 or 90 feet long. One of those plots was kept cultivated all season. On the other one the soil was scraped which left a hard surface. We placed tanks at the end of each of these two strips of land and used boards along the strips so that we would have a fairly tight border along the plots. Then we put in some duplicate plots on each side which had no tanks. On these we made moisture determinations during the summer, going down to four feet. The plot which was cultivated, of course, took in the most water and had somewhat the less amount of erosion and of course it had less runoff. Our moisture determinations in the soil beneath checked very well with the penetration of water, although there were considerable discrepancies. Nevertheless the averages showed what we could expect to find.

The next year we thought we would put out a real installation and the data from this experiment have already been published. That installation was carried on for six or seven years by F. L. Duley who is now at Manhattan, Kansas. We have now installed some additional plots, one group of varying lengths with the same slope, one is located on a rather steep slope, and some on different lengths of slopes and different widths. The original plots, as you may remember, were these: we had one plot which was left bare, with the weeds pulled up or scraped off with a hoe. Two of the plots were left bare, one being plowed four inches deep, and the other eight inches deep. These plots were both cultivated throughout the season at frequent intervals so as to keep down the weeds. We cultivated with a hoe, and plowed with a spade. One was in continuous corn, one in continuous wheat, and one in sod, and one a three years rotation plot of corn, wheat, and clover. We should have had three plots so we could have rotated them around completely, but at that time it did not quite occur to us that that was necessary or wise, and of course it added greatly to the expense to have two more plots. Our data, therefore, is on a single plot. This means that you must carry on your experiments for a considerable length of time.

I might say just a word about handling plots like these. It is not the easiest thing in the world to get comparable results, always. There are

many things to contend with. First, we have a great variation in seasons —rainfall of torrential character, and rainfall which is less torrential. If we have a torrential rain naturally we are going to get more runoff. At some times there is 95% of the rainfall runoff. There are other rains from which there is practically no runoff, depending upon the rain. We have one plot that has been kept in sod for 13 years, which allows practically no erosion to take place. We have a way of figuring theoretically how long it would take to erode 7 inches of soil, which is the figure commonly taken as the plow depth, under these different treatments. We figured that on the sod plot it would take about 4,000 years to wash off 7 inches of soil. One night a mole got into this patch and dug up the soil, but no one noticed it, until a rain came, and of course all of this loose dirt washed down in the tank below. Consequently it changed our figure from 4,000 years to 2,300.

I might say that the average results from the various plots have not changed very much. If you remember, these data were collected at the end of the first six-year period. Now we have a 12-year average, and the soil erosion average is very much the same. However, if one is to be reasonably accurate he must carry his experiments on for a considerable period of years to iron out the seasonal variations.

Another trouble we have at Columbia in handling this sort of thing is our winters. During the winter season with us, if we get any water in the bottom of the tanks, it will freeze and you can not do very much with it. Our winter rainfall, however, is pretty light, so it does not make much difference. We can get the total all right, but we can not get the individual rains very well. Then we had some difficulty in devising the best plans for sampling the material from the tanks. We are just now working on a device whereby we can use a large tube after we have thoroughly stirred the soil in the bottom of the tank, and then let it settle again and take a sample from the large tube, which has a closing device in the bottom of it. The common plan is to let the silt settle and then drain off the excess water through a tube. Then you take that muddy water in the bottom of the tank and transfer it to a large can or barrel and dry it and weigh it. That is a large amount of labor. We hope that possibly we can improve on this by getting some better sampling device.

Another thing that we have found which is very important is this—work your plots at about the same time each year. Now you can not always do that on account of the weather, but as nearly as you can, do it at the same time. Say you are working two plots which are both supposed to be plowed today. If you work one today and do not have time to do the other, there may come a big rain and you will get different results. The best way to do this is to spade 10 feet of one and then 10 feet of the other until you finish both of them.

I am going to say very little about the results until I can show a few slides. I might say just a little about the situation we have in Missouri at this time with reference to the whole matter of erosion and erosion experiments. I have already mentioned that we have had some very torrential rains during 1928 and 1929. It is very interesting, however, to know that the last 12 months, ending June 1, have been the lightest erosion months we have ever had. We have had very little rain this spring.

In Missouri we have two or three areas that are exceedingly susceptible to erosion. The first is our best land, and that is in the northewestern quarter of the state. Most of that soil is what we know as the Marshall loam, which is deep black. There is more damage being done on that soil in Missouri than on any other land. The reason for this is that those farmers are corn farmers. We have one county in northwestern Missouri that some seasons will have 70% of its cultivated land in corn. What can you do to keep land from washing away when it is rolling land and 70% of

it is in corn? Nothing. It is a silt loam. None of it is flat land, outside of the river bottoms. They list the corn in many cases and that soil is choking the streams and in many cases covering the improved highways with mud. The farmers realize this, of course, but have not done much about it. We hope, however, that with the agitation that is now on and coming, we shall get these people to begin to make an effort to improve this situation.

While I am mentioning level land I should like to say one thing about level lands. We have in Missouri one section of rather level land. All erosion is not harmful. Some erosion is necessary. The northeastern prairie land has been so level that there has been very little runoff. This flat land has been so level that through millions and millions of years there has been very little runoff. The water has stood and percolated through and as it percolated through it took out the lime, and the soil is now very sour, and of a gray color. Now even the organic matter goes into solution, and the soil is very poor. Under such conditions we have a great deal of weathering of the soil material. Thus the rejuvenation of the soil is necessary. It is excessive erosion that hurts. We have, beneath that land, very tight clay land. Some people call it hardpan. We do not call it that. Down three feet below is a layer of gravel. If land does not have some erosion it ultimately becomes badly leached and gray and infertile. You can dig down into those clay soils and you get buckshot. We have some areas on our second bottom land where the buckshot gets as big as hen eggs. So in order to keep land free of buckshot and to keep it from leaching excessively nature must gradually remove a little of the surface all of the time.

Another area in Missouri which erodes badly is the area on which we are establishing this farm. The Shelby loam represents south central Missouri. It is a prairie soil with timber along the streams. The soil is about 10 or 12 inches deep, not much of it 12. It has already reached an advanced stage of erosion so that the land is rather rolling. It is more eroded than the Marshall loam that we have already mentioned. It is a region where we have a large amount of pasture. The farms have been in cultivation for a long period of time. The things that we want to find out in this Shelby loam belt are these: (1) the type of cropping system which is best suited to that type of land; (2) what terracing will do on that land.

We do not know the soil type on which it will work best, but it seems that terracing offers something important on this type of soil. This is a region where the land is pretty well kept in grass because it does erode so badly. They would like to grow more corn. It is now imposisble to increase the percentage which can be put in corn. I wonder if it is not possible to terrace the land so that corn may be grown on it. At present only about one-fourth of it is in corn. Possibly with terracing we could increase it to one-third. I do not think we could ever increase it to one-half. I do believe, through terracing, it may be possible that we can increase the amount of land which can be safely put in corn. It is pretty good corn land.

One other thing we are interested in is the improvement of land that is already eroded. In erosion conferences like this we sometimes get the idea that once land is eroded it is hopeless. Sometimes it is. That, however, is not always true, and it is especially not always true when those eroded spots are just here and there on the farm. It would be a fine thing if we could find some way to bring those spots up to the marginal point. It would not pay to treat a whole farm, but it might pay to do a few spots that way. Before Duley left Columbia he started something along that line. He laid off three plots of exactly the same size and shape. From two of these plots all the soil was spaded off down to the subsoil. These plots were surrounded by wire curbing. One plot was left with the soil on. We tried different schemes to treat these to see what could be done. Generally speaking we did this: One of these plots which was desurfaced was limed

heavily, and a clover and grass mixture used. We fertilized heavily with commercial fertilizer. The other de-surfaced plot was left untreated and it has been left for these six or seven years. The plot which had the surface soil left on was left without treatment. During these years this de-surfaced plot which was limed and fertilized has yielded practically as good as the plot which was not desurfaced, and not fertilized. Some very interesting things came out of that. The mixture which was sowed there was a mixture of grass and clover, sowed on all of the plots alike. On the heavily limed plot the only thing we got was sweet clover. The soil had a darker look. We analyzed the soils recently and the nitrogen has accumulated, not greatly, but enough to see the difference. We have places in Missouri where the soil is sweet enough to grow sweet clover, on which, if the area is not too large, you can grow sweet clover a year or two and then turn it under and get enough nitrogen to make a tremendous difference. Then you can fertilize it and get favorable results. We are expecting to put out a series of small plots where the soil will be removed to see what can be done to vary the treatments under very carefully controlled conditions.

SOIL EROSION FROM CORN LAND VS. SOYBEAN LAND COMPARED
(Mo. Exp. Sta.)

	Tons soil eroded per acre annually
Continuous corn, no rye following	21.20
Continuous soybeans, in rows with rye cover following	19.51
Soil loss from soybeans 92% that from corn.	

EROSION LOSSES FROM LAND IN CONTINUOUS CORN VS. CORN IN ROTATION

	Continuous corn	Corn in rotation of corn, wheat, clover
Tons soil eroded per acre per year	17.06	3.40
Cubic feet runoff per acre per year	43559	16425
Per cent runoff	31.42	11.87

TWELVE YEARS OF EROSION MEASUREMENTS, 1918-1929
(Mo. Exp. Sta.)

Cropping system or cultural practice	Tons soil eroded per acre annually	Number years to erode 7" of soil
Plowed 4", cultivated, no crop	45.3	22
Plowed 8", cultivated, no crop	42.4	23
Continuous corn	20.4	49
Continuous wheat	9.6	103
Rotation—corn, wheat, clover	3.0	329
Continuous sod	0.4	2320

STUDY OF RUNOFF FROM TERRACED FIELDS

By

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This experiment was started in the fall of 1927 with the idea of determining which of the various grades and intervals in use for terraces were most effective in retaining soil and water and also noting the ponding caused by flat grades and consequent damage to crops and loss of time in cultivation.

As the project was outlined there were to be three series of four terraces each and one unterraced plot, measuring the runoff from each of these by means of 90 degree V notch weirs and recording liquid level gauges.

The first series installed was the series of terraces with a variable grade. That is, the upper end was level and the grade gradually increased to four inches per hundred feet at the lower end. One of these terraces had a vertical interval of four feet, one of three feet, one of two feet and the last of five feet.

The second series used the vertical interval of three feet which was the recommended interval on fields having a slope of five per cent. The field on which all of these terraces are has about this slope. The purpose of this series, however, was to determine the effect of grade of the terrace upon runoff. One terrace was laid off level, one with a grade two inches per 100 feet, one with a grade of four inches per 100 feet, and the last with a grade of six inches per 100 feet. While we were quite sure that six inches of fall was too much for the soil under consideration, we thought it wise to use a grade large enough to show a considerable wash as, at that time, there was in Oklahoma a tendency to lay out terraces with grades of six inches per 100 feet and sometimes even more.

The fourth series was a duplicate of the second except that the interval used was four feet. Two of these terraces were below the series of variable grade terraces and the other two were below the series with different grades.

The check or unterraced plot consists of a strip about 50 feet wide with embankments running parallel to the slope and extending a length of about 700 feet up the slope.

All 13 of these stations are now installed and results have been obtained from the first nine stations for over a year.

The results as shown during the year of 1929 are as follows:

VARIABLE GRADE TERRACES, 1929

Interval	Runoff inches	Rainfall from which runoff occurred	Per cent runoff
4 ft.	13.452	28.58	47.2
3 ft.	11.628	27.85	41.7
2 ft.	12.108	28.95	41.8

As there were some records lost the figures above do not include all the rains from which some runoff occurred. However, it will be noticed that as the interval increases the per cent of runoff also increases.

The effect of grade upon runoff is shown in the following table:

CONSTANT GRADE TERRACES, INTERVAL THREE FT., 1929

Grade	Runoff inches	Rain from which runoff occurred	Per cent runoff
Level	8.80	27.65	31.8
2 in. per 100'	9.77	27.50	35.5
4 in. per 100'	10.32	27.20	38.0
6 in. per 100'	5.78	14.42	40.3
Six inch grade installed May 25, 1929.			

It will be noticed here that the per cent of runoff increases as the grade increases.

The results for the year 1930 until June 1, are as follows, except that the runoff from melted snow and a light rain that followed are discarded because of the very irregular drifts in the field.

VARIABLE GRADE TERRACES, 1930

Interval	Runoff inches	Rainfall from which runoff occurred	Per cent runoff
2 ft	3.51	5.46	64.3
3 ft.	2.22	4.32	51.4*
4 ft.	4.31	5.54	77.7
*Runoff record of May 3, (1.74" rain) lost.			

CONSTANT GRADE, THREE FT. INTERVAL

Grade	Runoff inches	Rain from which runoff occurred	Per cent runoff
Level	2.56	6.06	42.2
2 in. per 100'	2.47	5.46	45.3
4 in. per 100'	2.77	5.67	48.4
6 in. per 100'	2.98	6.06	49.1

Another feature that must be considered in the construction of terraces is the maximum rate of discharge which should be expected from any given terrace. There are a number of factors which we would expect to influence this maximum rate. These factors are the intensity and duration of rainfall, soil type and condition, grade of terrace and interval of terrace. (Here Professor Baird exhibited curves showing the maximum rates of runoff obtained at Stillwater in two heavy rains of May, 1930.)

Noticing first the effect of grade. The maximum rate of runoff increases quite rapidly as the grade increases. One noteworthy exception is the higher rate of runoff from a level terrace than from one with a two-inch per 100 ft. grade. (Rain of May 3, 1930). I believe that this can be attributed largely to to a difference in soil as there is one quite large alkali spot in the area above the level terrace that does not absorb water readily.

In the rain of May 6, the soil was already saturated and this difference in soil did not make such a great difference in runoff.

Another interesting fact is that the discharge from the variable graded terraces was greater than that from the uniformly graded terraces. I believe that a part of this greater flow can also be attributed to the same soil difference.

The rain of May 3, 1930, was the most intense that has occurred at Stillwater since the recording rain gauge was installed and continued at about the same rate throughout the entire rain.

From these results small drainage ditches would need a capacity of 1.6 second feet or more for each acre in the drainage area for a rain such as we had May 3, 1930.

O. B. MARTIN, President:

I shall at this time introduce the worthy and useful president of the Oklahoma A. and M. College, who will in turn introduce the honorable Governor of Oklahoma.

DR. H. G. BENNETT, President,
Oklahoma A. and M. College:

You all know the interest which the Governor has taken in soil and water conservation work. Most of you know that he asked the legislature to set aside funds for this work. It is a pleasure for me to present Governor Holloway to you.

ADDRESS

By

W. J. HOLLOWAY, Governor of Oklahoma

I did not know that I was going to be called upon today to make an address. I am just passing through and had the opportunity to ride this far with your president. I like the atmosphere that I find on the A. and M. College campus. As governor of the State I like to feel that the money of the taxpayers is being well expended and I am always made happy when I see the real accomplishments that we are making in the educational field of Oklahoma. Many other states around us are making progress, but I believe you will pardon me for saying that I doubt if there is any state in the southwest that is making any more substantial progress than the State of Oklahoma is making. Our University, our A. and M. College, and our State Teachers Colleges are all really doing a good job and are rendering to the people of this state full value for the money that is expended for educational purposes.

I am particularly happy to fall into the atmosphere that I find on this campus. There are many problems and the educational institutions ought to help solve those problems. I believe you are doing it. For many years we have been trying to conserve everything that is in the air, in the sky, and on the ground, but we have not been conserving the ground itself. Some things that we see every day become so commonplace that we forget their value and forget their importance, and that is what we have done so far as the soil is concerned in so many parts of the country.

I am glad to see this audience—men and women who are tackling the question of soil erosion. It is becoming so important that even the candidates for office are giving a lot of stress to it in their campaigns. Those candidates are sincere about it. I think practically every candidate for governor has had something to say about his ideas of the importance of soil erosion and certainly nothing is more important to the happiness and success of the average citizen of this state than that the land be preserved and terraced and brought back to the condition in which we found it years ago.

Two or three days ago I made a trip in an aeroplane, and there you can get the best idea of soil erosion. It impressed me how the land was washing away—every way you looked.

I am glad to see so many representatives from my own state—Arkansas. I hope that next time we will have more here from Arkansas, because Arkansas is a good state. I suppose the boys are so busy keeping their land from washing away that they do not have time to attend conferences of this kind. I am glad to see the A. and M. College and Dr. Bennett taking such a fine lead in Oklahoma. It was not accidental that I put that part in my message when I first appeared before the legislature.

I am happy to be here and to get acquainted with you. If there is anything the State of Oklahoma has not done and can do in the next seven months, we will be glad to do it.

We appointed a special committee recently, headed by Director D. P. Trent, to arouse the people to the seriousness of the condition of the soil. Our newspapers are taking it up and with your interest and others who will be interested I know that something is going to be accomplished that is worth while.

I thank you for your kind attention, and appreciate this courtesy very much. I am sorry that I can not be with you longer, but I must get back to the hills of Arkansas.

SOIL EROSION WORK

of the

Bureau of Chemistry and Soils at Guthrie, Oklahoma

By

SAMUEL W. PHILLIPS

The program of the Bureau of Chemistry and Soils at the Guthrie Soil Erosion and Moisture Conservation Experiment Station was started a little more than one year ago. It includes the following major projects at present:

1. (a) Measurement of the soil and water losses by erosion and runoff, also to include the determination, by chemical analyses, of the kinds and quantities of plant food lost.

(b) Study of the effect of natural and burned vegetated areas on erosion and runoff.

2. Study of the moisture conditions and movements in soil under various systems of crops, soil management and on various types of terraces.

3. Comparison of yield and quality of crops produced on normal and eroded soils.

4. Effect of direction of rows upon runoff and erosion.

Other lines of work that we expect to get into as funds and time permit are:

(a) Effect upon erosion of organic matter such as sweet clover, etc., plowed under on eroded land.

(b) Effect of grain and legume stubble, straw, and manure on erosion.

(c) Effect of various rotations, fertilizers, and lime applications on eroded soil in the building up of these soils as measured by yields, and upon their water holding capacities and erosiveness.

(d) Special sampling in some plots, daily or periodically with reference to rains, to determine moisture penetration profile.

(e) Studies of some of the physical properties such as percolation, water retention, and development of erosion pavement under various crops and methods.

Soil and water losses are being measured on a set of nine small control plots. These plots are laid out on virgin soil with a very uniform slope of 7.7%. The soil was disturbed as little as absolutely necessary during the installation of the plots. Seven plots are 1-100 acres; one plot is 1-50 acre; and one is 1-200 acre. All are six feet in width. The soil type is Vernon fine sandy loam, which is widely developed in the Red Beds belt of Oklahoma and Texas.

Three plots, 36.3 feet, 72.6 feet, and 145.2 feet long, respectively, are continuously cropped to cotton to measure the relationship between length of slope and amount of runoff and erosion. All of the cotton plots are planted with rows down hill, but cultivated flat so that erosion is neither accelerated by ridges or beds nor impeded by cross rows ridged up. In other words, it is planned so that as nearly as possible the soil and water losses which occur shall be due only to the natural causes of soil type, slope and rainfall.

The next three plots are in a three year rotation of cotton, wheat and sweet clover. This set when compared to the third plot should give a measure of the relative effects of continuous cropping and rotation of crops upon erosional and water losses and upon the fertility of the soil.

The last three plots are in continuous Bermuda grass, bare, and eroded or desurfaced, respectively. The grass will be clipped to simulate grazing, the bare plot will be kept free of all vegetation and the plot desurfaced to

simulated eroded soil has had the surface soil removed to a depth of 10 inches and is to be kept continuously in cotton. From the first two plots we will get a measure of the effect of a good sod in checking erosion and a comparison with erosion which is permitted to proceed with no checks. From the desurfaced plot we will get data as to the rate of erosion on soil after the topsoil is gone and a comparison of yields of cotton with a plot of similar size and slope but in which the topsoil is intact.

I wish briefly to summarize the results obtained during the first year on these plots from early July last year just after the plots were constructed up until the last of May this year after the planting of the crops.

There were no very heavy rains after the first week in July, 1929, until the end of 1929. From January to the last of April, 1930, there were few rains and little runoff. However, during May, with a precipitation of 9.98 inches, which fell mainly in three periods of intense rainfall, we had some heavy runoffs attended by severe erosion. The rains of May 3 and 6 in particular caused heavy soil losses.

The runoff and erosion data from plots 1, 2 and 3 are very interesting. As stated below, these three comprise a set to study the effect of length of slope upon quantity of erosion and amount of runoff. As seen from Table I, plot 1, the short plot, had the highest soil loss per acre followed in order by plot 3 and plot 2. The percentage of runoff, however, showed the order to be plots 3, 1, and 2. The average runoff percentage increased slightly with length for an interval and then rapidly decreased. Soil erosion was greatest on the shortest plot, average about 5.4 lbs. per foot length of plot for this period, followed by about 4.4 lbs. per foot on the middle sized plot and 3.5 lbs. per foot on the long plot. These three plots may be compared to three terraced plots with vertical intervals of 2.8, 5.6 and 11.2 feet, respectively, for plots 1, 3 and 2.

The effects of a rotation are readily seen in the runoff and erosion figures for plots 4, 5 and 6. To me these are some of the most significant results of our first year's work. The rotation is cotton, with winter grain seeded in fall, and sweet clover in spring. The grain is taken off and sweet clover remains one year followed by cotton.

Plot 4 in wheat and oats (wheat winter killed and oats were substituted early in the spring) lost 25.5% of the rain but only 3.092 tons of soil per acre; plot 5, in sweet clover lost 506 tons of soil and 18.7% of the rainfall; while plot 6, which was in sweet clover from last year and plowed for cotton this spring, showed a loss of 20.5% of the rainfall and 12.67 tons of soil. Oats, while permitting about ⅛ more water loss than sweet clover, lost six times as much soil but only 1-5 as much was lost on the adjoining plot (3), which was in cotton last year and prepared for cotton with no cover crop this spring.

Plot 7, Bermuda grass, permitted a loss of 5.5% of the rainfall but only .06 tons of soil per acre.

Plot 8, kept free of vegetation lost 29.7% of the rainfall and 17.264 tons of soil per acre, while plot 9, the eroded plot in continuous cotton, lost 37.3% of the rainfall and 32.204 tons of soil per acre. From this we can state that soil erosion increases soil erosion on this type of land.

We have two plots in a wooded area, one of which is kept in its virgin vegetated condition, the other being burned over to destroy the forest litter. These plots have been in only for about 2 months. However, during the hard rain of May 3, the burned plot lost 210 gals., or 29.86% of the rain, while the normal virgin plot lost a very little over 1 gal. or .14% of the rainfall. During the period in which these plots have been in use, the virgin plot has lost a total of .09% of the rainfall and only a trace of soil, while the burnt plot has lost 10.18% of the rainfall as runoff and .169 tons per acre.

TABLE NO. I

Percentage Runoff and Wash (tons per acre) at Guthrie

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9
1929 July 3 to December 31 Rainfall 9.79"	2.02% .646 T	1.904% .276 T	1.82% .230 T	1.73% .246 T	2.93% .399 T	3.18% .339 T	.031%	7.33% 2.798 T	14.73% 1.865 T
1930 January 1 to May 31 Rainfall 16.91"	19.9% 19.43 T	14.25% 12.69 T	20.8% 15.959 T	25.5% 3.092 T	18.7% .506 T	20.5% 12.67 T	5.5% .06 T	29.7% 17.264 T	37.3% 32.204 T
Rains of May, 1930 Rainfall 9.98"	32.55% 19.43 T	24.04% 12.69 T	34.58% 15.86 T	42.44% 2.99 T	30.63% .480 T	34.29% 12.67 T	9.19% .06 T	47.31% 15.54 T	53.03% 31.56 T
				(Plots in rotation to)			Cont.	Cont.	Cont.
Treatment Length of Slope	Cotton	Cotton	Cotton	Oats	S. clover	Cotton	grass	bare	desur-faced
	36.3'	145.2'	72.6'	72.6'	72.6'	72.6'	72.6'	72.6'	72.6'

The runoff water is tested for nitrates as soon as possible after being collected and aliquot samples of water and eroded soil are kept from each runoff for complete annual chemical analyses. This analytic work is being done in the laboratory of the Oklahoma A. and M. College by members of the staff of the Department of Soils and Crops. We shall also make mechanical analyses of the eroded soil material.

As a means of determination of movement of the soil down the slope, elevation or level readings are made once each year over all plots. Three readings across each plot at one foot intervals up the slope are made for a total of about 2,200 readings on the nine plots.

The second major project, that of a study of moisture conditions and movement in the soil under various systems of crops, soil management and on various types of terraces, was begun last season and is to be continued. A set of plots, duplicate of the nine control plots, has been laid out and cropped exactly like the main plots. These plots are used for sampling in the study of penetration and movements of moisture in the soil. Samples are taken with a tube sampler. Samples have also been taken in the various terraced fields to obtain data upon the effectiveness of various types of terraces in moisture conservation. Samples were taken during most of last summer at intervals of two weeks and about once a month during the late fall and winter. This work will be continued with some variations from our procedure of last year. One of the difficult problems in this work, particularly in the terraced fields, is to collect samples that are really representative of the area worked. Should samples be taken in the terrace and ditch or restricted to the interval between the terraces? The terrace and ditch, together, comprise ⅓ or more of a field and are of a corresponding importance in the total yields. Our data after only part of one season is not very conclusive as yet, and will not be submitted here.

A comparison was made of the yield of cotton on the normal and eroded soil last year based on the small plot work. The stalks when measured showed an average height of 18.6 inches on the normal soil and 12.8 inches on the eroded soil, a difference of approximately 50 per cent.

As seen from Table II, the yield per acre of seed cotton was about 2⅓ times as large on the normal soil as on the eroded. The cotton matured earlier on the normal soil as shown by the approximately 95 per cent picking before the first killing frost as compared to about 50% picked on the eroded soil up to that date (latter part of October). Further, upon ginning it was found that the cotton on the normal soil ginned out 34.55% as compared with 32.47% for the eroded soil. The cotton lint yield on the normal soil was about 2½ times that on the eroded.

Through the cooperation of Dr. N. E. Winters and Dr. V. G. Heller of the Oklahoma A. and M. College, analyses were made to determine the ether soluble extract of the cotton seed. The results are shown in Table III. The yield of oil from the cotton seed analyzed about 12% higher for the normal soil than for the desurfaced soil and totaled about 2½ times as much per acre based on the yield of cotton seed.

TABLE II

Cotton Yields from Erosion Control Plots, Guthrie, Oklahoma, 1929—Variety—Triumph 44

	Seed Cotton per Acre		Total Average Ginning		Yield of Lint per Acre		
	Before frost	After frost			Before frost	After frost	Total
	lbs.	lbs.	lbs.	Per cent	lbs.	lbs.	lbs.
Normal soil	460.74	50.00	510.74	34.55	159.87	16.15	176.02
Desurfaced soil	110.94	109.38	220.32	32.47	36.98	34.56	71.54

TABLE III

	Cotton Seed per Acre and Per cent Ether Soluble Extract					Ether Soluble Extract per Acre		
	Before frost		After frost		Total	Before frost	After frost	Total
	lbs.	Per cent	lbs.	Per cent	lbs.	lbs.	lbs.	lbs.
Normal soil	300.87	29.49	33.85	28.12	334.72	88.73	9.52	98.25
Desurfaced soil	73.96	26.32	74.82	25.83	148.78	19.47	19.33	38.80

Analyses by Dr. V. G. Heller.

The above yields figured on the basis of lint at 15 cents and cotton seed at $30 per ton show that erosion caused a loss in the cotton crop of about $18.50 per acre. If the seed were sold on the basis of oil content at 7¼ cents per pound the return would show an additional loss of $4.35.

The work on the row direction plots was started this spring and the installation is not complete. Other lines of work are planned, particularly along the line of the effect of rotation and cropping systems, together with fertilizers and lime, on erosion, and the rate and cost of renewal of eroded soil.

Our experiences at Guthrie during the past year, and particularly during the past six weeks, indicate the importance of the role played by cover crops, legumes and grass in checking erosion. Fields which were not protected by crops, even though terraced, suffered heavily from sheet erosion. Terraced fields in oats were not greatly affected. In other words, while terraces will stop gullying, our quantitative measurements, so far as they have gone, indicate that without adequate soil-conserving cropping schemes sheet erosion can not be duly controlled. Cover crops, legumes, rotations and grass are particularly effective in checking surface erosion. The data collected this year seem to indicate that soil erosion is great or small depending upon the crop cover on the ground, and further that erosion does not always proceed in direct proportion to the amount of runoff.

During the early May rains, the short plot lost the most soil per acre, but as the soil became saturated with repeated rains, the runoff and erosion finally became proportional to the length of the plots.

Runoff has usually proceeded first from the bare plot, followed closely by the desurfaced plot, after which came the cotton plots. On the other hand it was greatly retarded on the oats, sweet clover and grass plots, but generally these latter plots and the long plot continued to run off for a longer period after rain ceased. It was very noticeable in the terraced fields this spring that the runoff from the oats, while never attaining the volume of that from the other fields, continued for a long period after the runoff from other terraced fields ceased.

The results of this first year's work indicate that runoff and erosion are governed principally by the following factors in the order of their importance:

1. Crops or vegetative cover.
2. Physical condition of the soil.
3. Intensity and duration of the rainfall.

RESULTS OF EXPERIMENTS ON EROSION CONTROL ON THE GUTHRIE SOIL EROSION EXPERIMENTAL FARM

By

R. E. RAMSER

Work on the research program of the U. S Department of Agriculture relating to soil erosion and moisture conservation has been in progress since the first part of January, 1929. Six experimental farms have been established at the following locations: Red Land Regions of Oklahoma and Texas near Guthrie, Oklahoma; Black Lands of Central Texas near Temple, Texas; Dark Prairie Lands of West-Central Kansas near Hays, Kansas; Grey Lands of Northern Missouri and Southern Iowa near Bethany, Missouri; Light Colored Sandy Lands of Southwest Arkansas, Northeastern Louisiana and East-Central Texas near Tyler, Texas; and Southern Piedmont Lands of Virginia, North Carolina, South Carolina, and Georgia near Statesville, North Carolina.

The experimental work consists principally of a study of runoff water and eroded material from various slopes and soils to determine the plant food, organic matter and soil losses; and of other investigations on different slopes and soils to determine the rates of runoff and extent of erosion on terraced and unterraced lands from which the proper fall, size, vertical spacing and permissible length for terraces can be determined. The effectiveness of terraces in conserving soil moisture is also being studied on fields where the terraces are laid out level and the ends are closed to retain all the water. Investigations on the design and construction of various types of soil saving dams built of different materials are also being made in their application to reclaiming and controlling gullies.

The principal purposes of these experiments are to demonstrate the economic need for soil conservation and to develop the most economic methods for the control and prevention of soil erosion. Millions of acres of land throughout the country today are satisfactorily terraced from the standpoint of preventing gullies and severe sheet erosion. The question is, are they economically terraced? Could the same results be obtained with terraces spaced farther apart, or with smaller terrace embankments thus reducing the cost of terracing? Are the terraces in some instances where the grade is large carrying off too much of the soil from the field or in other instances is an effort being made to conserve all of the soil at too great a cost resulting from more maintenance work, a closer spacing of terraces, and the possibility of damage to crop and unseasonable planting due to the wet condition of ground following heavy rains? Cannot improvements be made in the design of terracing machinery or new machinery be developed that will greatly reduce the cost of terracing work? Most farmers are convinced of the need for saving their soil and are primarily interested in the cheapest methods of soil conservation.

Differences in soil, topography, crops, rainfall, agricultural practices and climatic conditions account largely for differences of opinion in terrace design particularly in different sections of the country. It is believed that information required for the proper evaluation of the above factors for use in making recommendations as to the most satisfactory and economical methods of soil erosion control to be practiced in different sections of the country will be obtained from the results of the experiments on the widely separated soil erosion experimental farms.

Operations were begun on the Guthrie Soil Erosion Experimental Farm in January, 1929. The experimental work on this farm is being conducted in cooperation with the Oklahoma A. and M. College. Since the inception of this work about 20 acres of land have been cleared; 100 acres of land have been terraced, on which about nine miles of terraces have been built; 1800 feet of gullies have been filled with brush; and 45 brush dams, eight rock dams, four woven wire dams, and six pole dams have been built. About 60 acres of the land was planted to cotton and about 40 acres of the badly eroded and gullied land was planted to various cover and green manure crops the first year. A careful record was kept of the yields of cotton from two comparable areas of virgin and badly eroded land the first year. Both areas were terraced and have a slope of about five per cent. The eroded area had been under cultivation for about 30 years. A soil survey showed that practically no erosion had occurred on the virgin land and that 10 to 16 inches of the surface soil had been removed by erosion from the eroded land. A yield of 75% more cotton was obtained from the virgin than from the eroded area. It is believed that even a greater difference in the yields from these two areas will be obtained later since virgin land does not usually possess the physical charactesistics requisite for high productivity the first year.

This farm was settled under the Oklahoma Homestead Act of 1889. About 80 acres of the land was cleared and placed in cultivation between the years 1889 and 1906. Now this area which has been under cultivation is badly gullied and part of which was permitted to lie idle last year on account of its badly eroded and infertile condition. A soil survey shows that from three to 24 inches of soil have been eroded from the area under cultivation as compared with practically none from the virgin area and the numerous gullies range in depth from two to 10 feet. The bottoms of all the deeper gullies are down to bed rock. The surface soil on the farm varies from a fine sandy loam to a loam and in eroded spots it is a clay loam.

Five sets of terracing experiments have been laid out on this farm. One set consists of six terraces 700 feet in length with a uniform fall of four inches in 100 feet and vertical spacing between terraces of 2, 3½ and 5 feet. The slope of the land varies from five to seven per cent. Measurements of rainfall and runoff are made for this experiment. The amount and intensity of the rainfall is measured by means of an automatic rain gauge which records the amount of rainfall to nearest .01 inch and the time to the nearest minute. Parshall measuring flumes are installed at the ends of the terraces to measure both the amount and rate of the runoff. The flow through these flumes is recorded by means of a float gauge operated by a clock which records the depth of the water in flumes to the nearest .01 foot and the time to the nearest minute.

This measuring device was selected in preference to the ordinary weir since experiments show that the discharge will not be appreciably affected by the velocity of the water entering from the terrace channel, and the discharge through the flume for any particular stage is not appreciably affected within certain wide limits by the stage of the water in the outlet channel. Such a device eliminates the necessity of storing any of the water to reduce the velocity of approach before the discharge is measured and the necessity of providing a deep outlet channel to preclude the possibility of backwater affecting the accuracy of the measuring device. Another important reason for choosing this device is that its design is such as to reduce the possibility of silting to a minimum. The greater velocity in the contracted section near the middle of the flume tends to carry away any silt or drift which has been transported to this section by the slower moving water in the terrace channel and upper part of the flume.

On May 3, 1930, a rain of 3.22 inches occurred, 1.8 inch of which fell in 25 minutes and 0.5 inch in five minutes. The intense rain of 0.5 inch falling in five minutes was a critical test for these short terraces. The water in the channels of the terraces with five-foot vertical spacing reached a depth of nearly 17 inches, about 14 inches in the terrace channels with 3½ foot spacing and about 10 inches for the two foot spacing. From these depths of water in the terrace channels can be determined the height for terraces 700 feet long for the above spacings for the particular soil and land slope required to withstand an intense rainfall of ½ inch in five minutes which judging from past Weather Bureau Records would occur about once in 10 years. As soon as silt measuring devices are installed on these terraces the amount of soil that is being carried off in the runoff water will be determined and the results of these measurements will be given due consideration along with the runoff water in making recommendations for the spacing of short terraces on moderate slopes. Also the proper height to build terraces on this particular slope from the standpoint of farming practices and convenience in the use of farm machinery will be given due consideration in arriving at the proper spacing of terraces.

The second set of terracing experiments consists of four terraces 1,500 feet in length, with an average vertical spacing of about 3½ feet and with grades as follows: level, two inches, four inches and six inches per 100 feet. The slope of the land is about 4.6 per cent. Flumes have been installed on these terraces for the measurement of the runoff and silt measuring devices have been installed on the terraces with two and four inches fall per 100 feet. This device or silt sampler consists of a wooden box 5 feet wide and 10 feet long installed below the lower end of the one foot measuring flumes. Larger boxes will be used where larger measuring flumes are needed. The purpose of this box or basin is to trap all the heavier material in the runoff water. The amount of this material is measured but in order to obtain the amount of silt escaping over the weir at the outlet end of the box a proportionate amount of the discharge for all stages of flow is taken out through a notch in the side of the box and stored in a large tank. The silt content of the water in the storage tank and the amount of silt that is trapped in the basin is determined and with this information and the total quantity of water discharged from the terrace, the total amount of silt in the water discharged for each rain can readily be computed. After the intense rainfall of May 3 during which 3.22 inches fell in about 1½ hours and 1.8 inches in 25 minutes, between four and five times as much material was caught in the silt box below the terrace with four inches fall as in the box below the terrace with two inches fall per 100 feet. While the level terrace 1,500 feet long and with only one end open has withstood successfully several large rains, there is a tendency for the channel to remain wet after rains and thereby interfere to some extent with the farm operations. The results so far obtained indicate that the grade of a terrace has a very decided effect upon the amount of soil removed by the runoff water and that it should be given careful consideration in the design of terraces without overlooking however the necessity for removing the water in time to prevent overtopping of the terrace or the necessity of preventing water from standing above terraces long enough to cause material damage to crops or interfere seriously with timely farm operations.

A third set of experiments consists of five graded terraces each about ½ mile long. Two of these terraces are on virgin soil and have variable grades. The grades increase from level to four inches per 100 feet for one and from level to six inches per 100 feet for the other. Three of the terraces are on badly eroded land. The grade of one of these terraces varies from level to four inches per 100 feet and for another from level to six inches per 100 feet and the third has a uniform grade of three inches per 100 feet. Measurements of runoff and silt losses will be made at the ends

of the terraces to obtain data on the virgin and eroded land and for the different grades for long terraces. So far observations show that some erosion occurs in the terrace channels near the ends of all the long terraces and that more runoff occurs from the terraces on eroded than on virgin land. In the construction of these terraces and those of the preceding experiment, furrows were left on the lower side of the terraces. During the recent heavy rains these furrows filled with water, ran over at the lowest points of the furrows and eroded gullies down the slopes between terraces. This erosion was very pronounced on clean cultured fields but did not occur to any appreciable extent on the terraced land planted to oats. Erosion at the ends of several of the terraces occurred due to water dropping into an outlet ditch and eating back along the terrace channel. This is a very common cause of gullying back along a terrace channel. Also on several terraces where sharp bends occur the terrace embankments were cut partly away by the runoff water.

In the graded-terrace experiments the principal information that will be obtained will consist of the proper size for the terrace channel, the proper spacing, the fall and the limiting length of a terrace for the particular vegetative covering, soil and land slope. These factors are all interdependent so that a change in any one affects all the others. For instance, the size of the cross-sectional area of the terrace channel depends upon the length and spacing of the terraces which together are the factors that determine the size of the drainage area and since the amount of runoff increases with the size of the drainage area, the larger the drainage area the larger must be the cross-sectional area of the terrace channel to remove the runoff water, other factors being constant. It also depends upon the fall since, with other factors remaining constant, the larger the cross-sectional area, the smaller may be the fall since the discharge capacity of a terrace channel is governed by both the fall and the cross-sectional area. Upon the nature of the vegetative covering, the kind of soil and the inclination of the land slope depends the percentage of the rainfall that runs off and the greater this percentage the greater will need be the cross-sectional area of the terrace channel, other factors remaining the same. From the foregoing it is apparent that a great variety of factors enter into the design of a terrace. It is the problem of the engineer to adjust the relation of these factors in such a manner as to prevent any appreciable erosion on the land slope between the terraces and in the terrace channel, and at the same time to provide sufficient capacity in the terrace channel to prevent the runoff water from overtopping the terrace with the usual disastrous result to the field and the terraces below. The results of these experiments will provide information required in the determination of the proper relation of the various factors involved for the particular soil and land slopes where the experiments are located.

In the two sets of level terraces on the Guthrie farm it is proposed to obtain information on the proper spacing of level terraces and the effect upon crops of water standing above the terraces after rains. In one set of experiments the level terraces are spaced 2, 2½, 3, 3½ and 4 feet apart in vertical distance on a slope of about 4½ per cent and all of the rain water is retained on a 100-foot length at one end of the terraces. Staff gauges installed in the channel above these terraces are read at intervals after rains from which information on the time required for the water to percolate into the ground will be obtained. Similar measurements and observations are being made on two terraces that encircle a knoll near the center of the farm and have no outlet. During the first spring season it was found that the water stood above these terraces several days after a heavy rain with considerable injury to crops in the terrace channel and caused a delay in tilling and seeding the land in the spring. Half of the land between the terraces was subsoiled about 14 inches deep in the fall and the rains this

spring seem to show the subsoiling has had no appreciable effect which is due no doubt to the very impervious subsoil. It is believed that information thus far obtained is sufficient to show that level terraces with no outlet would not be satisfactory for the type of soil on the Guthrie farm. Level terraces with open ends appear to give satisfactory results for short lengths and fairly so for lengths up to 1,500 feet. However additional information is needed before any definite conclusions can be drawn. Similar level terrace experiments are included in the program for all of the experimental farms. The results of these experiments will furnish an index for comparing the rate of percolation of water into the different soils in addition to valuable data on the effect of conserving all of the moisture for crop production. The rate of percolation of a particular soil will furnish valuable information required for use in the proper design of both level and graded terraces. While in some instances it may appear to be a foregone conclusion that certain soils are too impervious to permit the retention of all water by level terraces with closed ends without serious damage to crops, accurate information on this subject will have decidedly more weight in convincing skeptics than mere opinions unsubstantiated by facts.

During the past spring an opportunity was afforded to determine the effect of terraces upon soil losses during heavy wind. It was found that considerable wind blown soil collected in the terrace channels. On one particularly badly gullied slope the gullies above the terraces were partially filled with wind blown soil and the gullies on an unterraced part of this slope also caught large quantities of soil, which however was washed out and carried off the field during the first heavy rain as compared with the retention of this wind blown soil on the terraced land.

In addition to the information to be obtained from the foregoing experiments, considerable data have been collected on the cost of constructing terraces of different dimensions with different terracing implements. A sufficiently detailed study of these data has not been made to warrant its complete publication. The costs of the construction of terraces under normal conditions of soil and operation with tractor power ranged from $20.10 to $45.30 per mile of terrace and from $1.92 to $4.22 per acre. The height of these terraces ranged from 1.1 to 1.6 feet and the base widths from 20 to 25 feet. The vertical spacing of the terraces varies from two to 4.6 feet and the land slope from three to 4.4 feet per 100 feet. The soil ranges from a badly eroded clay loam soil that has been in cultivation for 40 years to a virgin fine sandy loam.

One field on the Guthrie farm was covered with a growth of scrub oak trees and sprouts which greatly interfered with terracing work. Also many rocks and roots hindered the progress of the work. The slope of this field varies from five to seven per cent and the average vertical distance between terraces is about 3½ feet. The cost of terracing this field with terraces 20 feet wide and 1½ feet high amounted to about $13.00 per acre. In computing these costs on terrace construction, some allowance was made for the depreciation of machinery. These costs may be modified somewhat later when more definite information is obtained on the proper allowance to be made for depreciation.

It was found that several variable factors affect the cost of construction of terraces. Some of the factors are the nature and conditions of the soil, the length of the terrace, the vegetative covering, kind of implements used, the methods employed and the experience, skill, intelligence and vigor in prosecuting the work, of the operator. In some instances constructing a terrace in wet soil might easily double the cost. It requires more time and labor to build a terrace in a heavy clay than in a sandy loam soil. A short terrace costs more to build than a long terrace due to the greater percentage of time required in turning equipment at the end of terraces.

Vegetative covering such as long grass is most generally a source of great annoyance in terrace building and greatly retards the progress of the work. Roots, rocks, sprouts and stumps add materially to the cost of terrace construction and in many cases would likely make the cost of terracing prohibitive. Generally the amount of terracing work done by a farmer on his own farm is not sufficient to make him proficient in terracing work. Two operators differing in skill, vigor and intelligence may readily cause a variation of 50 per cent in the cost of the construction of terraces even where both are experienced. Also, until an operator gains sufficient experience, the cost of constructing terraces is appreciably larger. To these many variable factors and to the fact that very little reliable cost data has been collected may be attributed the great difference of opinion among farmers and engineers with regard to the cost of terracing work.

Some observations were made on the cultivation of terraces. Most of the cotton rows were run parallel to the terraces the first year to give the terrace embankments a chance to settle. This year the rows will be run across many of the terraces and a comparison will be made of these two methods of cultivation as regards injury to terrace, ease of cultivation and time employed in cultivation.

Lines have been laid out perpendicular to the contours in several locations on the Guthrie farm to determine the soil movement down the slopes for unterraced land, level-terraced land and graded-terraced land. Permanent concrete posts have been set at the upper and lower ends of these lines. Accurate measurements will be made every year to determine the elevation of points along these lines at intervals of six inches. From these measurements information will be obtained on the soil movement down the slope for both terraced and unterraced land. It is generally known that terracing does not entirely prevent but simply retards the soil movement down the slope. The effectiveness of terracing is measured by the extent to which this soil movement is retarded and a comparison of the profiles taken along these lines on the unterraced and terraced land with different spacings of terraces will afford information on this subject. As stated, the measurements along these lines will be made every year. It is not thought however that information obtained from these experiments will be of much value before a period of about five years has elapsed and that the longer the experiments are continued the more valuable will be the results obtained.

In checking erosion and filling in gullies on the farm an effort was made to employ the simplest and cheapest methods. Practically all material used with the exception of a few spikes and smooth wire was available on the farm. Brush was used in building most of the check dams in the gullies. This brush was obtained from the clearing of land for cultivation. The limbs were trimmed from the trees and the poles obtained were used in building pole dams. The area where most of the brush dams were built was not terraced until fall when there had been sufficient filling of these gullies due entirely to spring and early summer rains to enable crossing them with terracing machinery after the edges had been plowed in.

Rock was found on the bottoms of most of the gullies so that it was impossible in most cases to anchor dams by driving stakes into the bottom of the gullies. In building brush dams where rock was encountered the dams were anchored by means of poles, the large ends of each pole being set in the ground near the bottom of the side of the gully, bent over the brush and fastened to a stake on the top of the bank. The brush was laid with the butts upstream. The poles cross at the center of the gully and thus form a low place for the water to flow over without eroding the sides of the gully. These dams are usually built 10 to 15 feet lengthwise of the gully and three or four sets of poles are used to anchor them down.

A number of loose brush dams, some weighted down with rock, were built. Most of the silt above these dams was caught during one heavy rain of about 2½ inches. One loose brush dam in this gully was floated down to the next dam below which was fastened. It was found that not much dependence can be placed on loose brush dams where there is considerable flow in a gully. The greater the flow the more securely should brush dams be anchored.

The brush was carefully placed in one gully with tops upstream in the manner in which a house is shingled and was weighted down with rock. The brush in this gully which varied from about three to eight feet deep caught silt nearly to the top of the brush in the upper end of the gully as a result of about four rains. Where plenty of brush is available this is a quick and effective method of reclaiming a gully. After terracing the gully could be crossed over with farm machinery.

Check dams built with small poles laid across the gully and fastened together with spikes were also used. Poles extending lengthwise of the gully form an apron below to prevent washing and undermining the dams and the notch in the center permits the water to pass through without eroding the sides of the gully. As the dams were built the poles were laid in grass or straw and after completion earth was placed and tamped above the dams to prevent possible flow through the dams. Where earth was not placed above for experimental purposes considerable washing occurred around the ends of the dams. There are six dams in this gully and they are 1, 1½ and 2 feet high and spaced so that the crest of one dam is at the level of the foot of the dam above. These dams which are non-porous have been very effective. Most of the silt which is up to the level of the crest of these dams was caught during one heavy rain of about 1¼ inches. About one year after the construction of these dams sufficient silt was caught to permit farming across the gully.

On the Federal Soil Erosion Projects research work will be conducted relating to all methods of preventing and checking erosion, but special attention will be directed to terracing. Terracing undoubtedly has the widest practical and general application in the cure and prevention of soil erosion. It may be applied to conserve the fertility of virgin soils, to preserve the remaining fertility of depleted soils where erosion has been active, and to restore fertility to gullied and badly eroded lands that have been abandoned for cultivable purposes. Terraces can be designed and constructed so as to save practically all the soil or very little. On the one hand, level terraces with ends closed so as to retain all of the rainfall permit practically none of the soil to escape from the field, while, on the other hand, terraces with a large fall to carry the water off of the field also generally carry away much of the soil that accumulates in the terrace channel. Owing to the fact that the latter method prevents the development of gullies in a field, the farmer is often mistakenly led to believe that he has successfully stopped erosion and its accompanying soil losses. These two extreme methods of terracing also represent two extremes in cost of construction and maintenance per acre of field terraced. The cost of construction of a level-terrace system is larger than a graded-terrace system since level terraces must be placed closer together or built higher in order to store the runoff water which is permitted to drain off in a graded-terrace channel. The cost of maintenance is also larger since there is a certain amount of soil movement down the slope between terraces and the accumulation of this soil in a level-terrace channel is faster than in a graded-terrace channel, for the reason that most of the soil remains in a level-terrace channel and part is removed by the runoff water in a graded terrace channel. Maintenance work consists partly of cleaning the accumulated soil out of the terrace channel and using it to strengthen the terrace embankment.

Soil movement down a slope between terraces can be greatly retarded by methods of cultivation and cropping, but it cannot be entirely prevented where cultivation is practiced. From the fact that soil movement down the slope of a cultivated field cannot be entirely prevented, it is apparent that terracing does not stop this movement but merely retards it. It is however sufficient that terracing retards it, if the rate of retardation is great enough to permit the soil to be built up by geological processes, methods of cropping and possibly the application of fertilizer at a rate sufficient to maintain the soil in its original fertility. For most land however it is believed that the rate of building up the soil in terraced fields under good farming methods will be faster than the tearing down process due to the soil movement down the slope.

Up to the present time there has been practically no study or consideration given to the economics of terracing. Only a careful study of this subject involving the consideration of the many cost factors and influencing conditions together with the degree of erosion control will enable the engineer to specify with precision the sort of terrace best adapted to any particular piece of land. It is hoped that the results of the experiments on the Federal Erosion Projects will afford information of value required in a much needed economic study of the terracing problem. Until such information is available, however, it is important that terracing work be pushed vigorously since the great benefits derived from terracing are so self-evident that the good work should continue unabated regardless of the possible improvements that could be made if adequate experimental data were available for present use.

ENGINEERING EXPERIMENTAL PROGRAM OF THE SOUTHWEST

By
L. A. JONES, Senior Drainage Engineer
U. S. D. A.

Under the state of Nature, I think it is pretty well understood that erosion is balanced. Nature has a way of preventing erosion. Man is the disturbing element. We have heard this morning and this afternoon the importance of soil and the effect of crop rotations on erosion. Undoubtedly crop rotations have a very important place in soil erosion. If we grow the type of crops that we want to grow, we feel that it is much to control erosion by artificial means. The object of the engineering experimental program of the southwest is to develop the most economical type of engineering structures for the control of erosion under the conditions of soil slope and rainfall found in the region. That is the definition of the engineering experimental work that we are undertaking.

In addition to the development of this type of control we have in this southwestern country especially the development of such a structure that the large farm machinery can be used without trouble. The work in terracing is being developed with the idea of finding the most economical method of designing and constructing a terrace. We find the most satisfactory length and slope of terrace under most conditions in which we have already obtained information, is obtained by finding the best depth of cross section and to develop the most economical method of constructing terraces. I believe we are a long way at the present time from developing the best method of constructing terraces. I am hoping that our work will develop much simpler methods of constructing terraces. The effect of such operation upon the terrace is a very important phase of the work. There is too much work involved. I am sure that in a large part of Oklahoma and a large part of Kansas and especially in Iowa, Missouri and Illinois we are going to have great difficulty in getting the farmers to terrace if we cannot devise a system whereby they can use the modern farm equipment. After we develop a terracing system, we must develop a method of maintenance. I believe it will be possible that in doing some of the regular work of the farm, the farmers can assist in maintaining the terraces. We hope that we can devise methods of plowing that will maintain the terrace with comparatively little extra work.

In addition to the work on terraces, we have the problem of gullies and their control. We must devise the most economical method of checking the gullies. In connection with drainage and flood control, the runoff studies on these soil erosion farms are of utmost importance. The division of agricultural engineering has been carrying on such studies for 25 years. We lack information on most areas to determine the sizes of culverts for roads and the sizes of highway ditches. The principal reason that the terraces mentioned failed was the fact that the outlet ditch was of insufficient capacity and was not protected from the silt coming from the adjoining land.

HANDLING RUNOFF FROM TERRACED FIELDS

By

L. E. HAZEN, Agricultural Engineer

Oklahoma A. and M. College

While it seems to me there are full and sufficient reasons for each statement I make, yet I want to make it clear that no experiment station setups were made to ascertain the accuracy of these premises; but I am unique among terracing advocates in having paid for my first hand information on a small project of my own, and supplemented this with field studies in nearly every section of this state. There are five points I want to make, and while I shall not pause for discussion of the modifications and exceptions, I do want to dwell fully enough on these factors that their importance is emphasized; and their success in practice has been established.

First, a terrace is a mechanical means of replacing the sod and timber of virgin country to hold water where it falls for a sufficient period of time to permit deep percolation, seepage, and surface drainage to remove the excess. These three processes gave us the clear, steady flowing streams throughout much of the season. If we could subsist on grass and trees alone, we would not need to terrace; and we can't hope to till sloping fields without some method of controlling the erosion due to torrential rains.

Second, a terrace is a reservoir; designed as a reservoir, built as a reservoir, and cared for as a reservoir if it is to succeed. It is not an irrigation device nor a drainage ditch, and if we confuse these ideas trouble with terrace layout is inevitable. In a good job of terracing we are creating bottomland conditions on upland, and following a crooked terrace ridge with cultural processes is no different from following a creek bank which goes winding along. Since a terrace is merely an earthen tank, the soil types are of little or no importance so long as they are tillable. The terrace is the same for loam, sand, or clay; its design is the same. The factors which are important are rainfall, surface slope, and tillage practice. It is on these that rational design must be based.

Handling the Runoff from Terraced Fields

Third, in nearly every job of terracing we are confronted with the problem of excess water, and that this feature of erosion control is fraught with difficulty came to my attention very forcibly 10 years ago. I came here with no training whatsoever in the practice of erosion control so depended on what I heard and read to serve as a guide. My first terrace on my own place was laid with a variable grade from 0 to 0.3% as was being recommended by the College at that time. A heavy rain sent water at an approximate rate of 100,000 gallons per hour through the outlet for a period of nearly two hours and cut a gully along the terrace line three feet deep and seven feet long. The channel for 200 feet was swept clean of silt and it required nearly a day for a team and fresno to take the silt from a pond I contemplated using as a reservoir for water supply.

About this time I laid out a line near Norman and was confronted with the same discharge damage. I plowed down my graded terrace and relaid it level, and constructed a stone orifice for the discharge. It now requires 24 hours to drain this terrace at a rate of 10,000 gallons per hour following a three-inch downpour. For this reason I lay all my terrace lines level, and while the use of sodded flatbottomed ditches is all right if we keep fire and stock away, I believe we must resort to baffels or tile in most cases and keep the cost of these structures down by holding the water within the terraced area itself for a period of hours. I do not want any ditch in front of the dyke, I insist on the major portion of the area being under water before the dyke is in danger, and the rate of runoff be so slow a small dis-

charge line can handle it, and the water which drains away be fairly clear. I am designing the layouts I personally assume responsibility for to hold an eight inch rain without regard to the possible percolation or runoff; and so far I've not had a failure. I use the formula

$$D = \frac{75h^2}{s}$$

in which D=the distance between terrace dykes,
h=the height of the dyke above the original ground,
s=the slope in feet per 100 between dykes.

You will notice that this is independent of terrace length and rate of precipitation, and takes no account of runoff and percolation. By varying "h" we can meet the cultural requirements of low slopes such as we find in the wheat fields near Enid, or figure the high sharp ridges necessary for contour farming on steep slopes. It is based on an eight inch downpour. If we have reason to question eight inches as the proper limit then the formula can be written

$$D = \frac{600h^2}{rs}$$

in which "r" is the rain expressed in inches, which we expect to hold. This gives a spacing of 60 feet apart for dykes two feet high on five per cent slopes, and 75 feet on four per cent, with an eight inch rain capacity.

Fourth, the structures for disposing of the runoff should be laid out and built before actual construction of the ridges themselves is undertaken. At present we lay out terraces, then go onto the job later and try to check the hideous gullies the discharge cuts along line fences and roadsides. It is just as much of a mistake to neglect draining off extraneous water as it is to keep it impounded until crops are drowned and the soil puddled. The cause of level terraces has been unjustly injured because in so many cases this matter of surface drainage was not provided for. While I claim that terrace design is not a matter of soil texture, I want to make it very emphatic that the art of soil drainage is very largely one of texture, and a keen study of soil characteristics should engage our attention in its relation to water utilization. A tile system in tight soil is one thing, in sandy loam, another. Nature protected her hillsides against erosion, but put swamps on the bottoms. A level terrace will establish swamp conditions on certain soils, yet swamp land properly drained demands high prices.

Fifth, we must note that the machinery for erosion control is still an object for study. We expend enormous amounts of power in sliding friction over grader blades, and moving surface dirt laterally. I dread the cost of building terraces of the widths usually recommended and farmers are loth to undertake so exacting and costly a program. Instead of building our dykes of subsoil, and leaving our top soil for crop production, we scrape off from 10 per cent to 20 per cent of the surface to build a dyke on which only about three per cent to five per cent of the crop can grow, and wait for natural weathering and washing to cover the scraped areas on each side of the dyke. I have faithfully scraped away the top soil, built the core of subsoil, then returned the top dirt, in a number of instances, but it is a slow, tedious process. The whole job of gully fills and dykes is a tedious process for that matter, and when built they settle and require annual attention.

We need more contour tillage, and while real crooked rows are hard to follow with horses, the general purpose tractors with tillage implements attached are solving this problem. A narrow ridge terrace is difficult to mow, cannot be crossed with implements, makes a break in the sequence of rows,

but it is economical to build, and can be widened with less power expenditure than is needed to make it full width at first. I have been severely criticized for recommending that we build our terraces full height the first year, and obtain a desirable width by plowing to the ridges and surfacing over from season to season so as to attain the width in about three to five years. But as I said before, I've paid for some of my own terraces, and met the costs of my own recommendations, and I cannot retract these recommendations in the light of my own practice. Whether he recognizes it or not my system is exactly what the farmer is doing as a rule, his terraces grow narrower as he goes down the hill and only time will induce him to widen them as the soil settles. But the greatest single stumbling block I meet is the fact that few farmers appreciate what terrace height really means. They will declare ridges to be two feet high when actual measurement shows them to be only nine inches, and to be 30 feet wide when the dyke is really only 10 or 12 feet. They are deceived on height by the ditch the grader cuts, and on width by the surface they have denuded of productive top soil. They think they have an effective ridge because lots of surface is torn up, yet it is readily overtopped by a two inch rain if the concentrations reach 0.6-inch per hour, and all the water capacity present is the ditch itself. A terrace two feet high and 12 feet wide looks mighty tall and wide to the farmer who is sure his are that large, and in the trips we are taking in connection with this conference I can assure you there are none that size. The station at Guthrie comes the nearest to having full scale structures and most farmers seeing those dykes over there are staggered at the job they still have uncompleted at home. It is easy to get the width, if we are content with little height; it is easy to get sufficient height if we are willing to place the dykes closer together; but it is not easy to make adequate gully fills, full scale dykes, and permanent drainage lines on the poor soil needing it most vividly and pay out on the investment.

REPORT ON PROTECTING ROAD AND HILLSIDE DITCHES WITH CONCRETE BAFFLES

By

W. H. McPHEETERS, Member

Soil Erosion Committee, A. S. A. E.

Baffles are comparatively new in Oklahoma. It was a little over three years ago that I became interested in them. There were just a few baffles in the state at that time, most of them being in one county and built by the same man. Knowing the necessity for ditch protection and observing the good accomplished by these baffles, which were rock walls in the road ditch, is what got me interested in the subject of baffles for ditch protection. Since that time I have given the subject a lot of thought and have tried out various kinds of baffles and used different methods of constructing them in order to find a baffle that will serve the purpose best and at the same time be economical.

The Oklahoma State Highway Department, during the past year, is also doing quite a lot of work with baffles or retarders, as they call them.

Mr. P. C. McGrew of the Federal Experiment Farm at Guthrie, Oklahoma and I, both members of the Soil Erosion Committee, were given the subject of baffles for ditch protection to work on during the past year. I shall endeavor to give a few things we have found out.

In the road ditch along the Federal Farm at Guthrie where the terraces empty, we constructed a number of baffles using various designs and also different methods of construction.

At Guthrie, we built a concrete baffle using a form and one of the same capacity without the aid of a form. We found that it takes less labor and less material to build a baffle without the use of a form than it does when using a form. This fact was also verified by a similar test at the Oklahoma A. and M. College farm.

We built baffles of several different shapes at Guthrie; one having the water gap straight across the ditch, one having the water gap in a circular form and one making the water gap almost in the shape of U in order to increase the capacity of the baffles without widening the ditch. The U throat was made level. After a very heavy rain we found that this shape throat or water gap tended to throw the water against the wings. If the center had been made a little lower this probably would not have happened.

We built one baffle by the aid of a semi-form, i. e., we used a form in the back wall, giving the water a vertical fall and made the sides sloping as in the other baffles, using no form. This is a very promising type of baffle, both from the standpoint of efficiency and ease of construction. This fact was verified at the tests made at Sulphur June 16, 1930.

We built two wide baffles with short drops in a swag that carries considerable water. These baffles each have a water gap 12 feet wide, eight inches deep and a drop of 16 inches. One of them has a projection at the bottom to break the force of the water. We have not been able as yet to determine whether or not this is of any value. The idea of building this type of baffle is to have a flat ditch that can be kept in grass and used as a turn row.

The following table gives the amounts of material and man hours of labor for constructing the baffles on the Federal Farm at Guthrie:

Material and Labor Used in Constructing Baffles, Federal Erosion Experiment Farm, Guthrie, Oklahoma

	Baffle No.	Size of Throat		Drop inches	Fall between baffles inches	Digging man hrs.	Labor		Cement used sacks	Remarks
		Width inches	Depth inches				Set forms man hrs.	Pouring concrete man hrs.		
Road Ditch	1	36	8	24	0	3½	1	4	2½	1 ft. sand rock
	2	36	8	24	0	2¼	0	4	2¼	Clay, tough
	3	39	10	20	0	1¾	0	4	2	Clay, tough
	4	39	10	22	4	2¾	0	4¾	2	Clay, tough
	5	51	10	24	2	2¾	0	4¾	2½	Clay, tough
	6	57	10	22	2	2¾	0	4¾	3	Clay, tough
	7		11		4	6	1	3	3⅓	2 ft. sand rock
Field Ditch	1	144	6	10		1	0	4	2¾	Clay, tough
	2	144	6	12	3	1¼	0	4	3¼	Clay, tough

I have helped to build baffles in the following counties: Alfalfa; Garfield; Canadian; Cotton; Okfuskee; Creek; Garvin; Carter; Payne; Logan and Murray.

The length of this report will not permit a discussion of many of these; however, a short discussion of a few of them may be of interest. In Cotton county near Walters, Oklahoma, I helped to construct one baffle on Mr. Sudduth's farm, after which Mr. Sudduth went ahead and built 16 more. No forms were used. He did a good job and the baffles took care of the water from the heaviest rain. Mr. Sudduth thinks these baffles are the proper thing to protect the ditch that carries terrace water.

Near Wynnewood I helped with two baffles and a drop from the terrace ditch to the road ditch. The drop in the road ditch was made to curve down the road ditch in order to discharge the water in the direction of the water in the road ditch. The wall of the baffles nearest the road ditch proved to be too low; so the water coming straight down the ditch overshot it. This can be remedied by building this wall a little higher. It is a question in my mind yet whether this is better than emptying the water at right angles to the road ditch. All the baffles in this ditch were completed after I left, and took care of the heavy rain.

In most of the counties mentioned above, concrete drops from terraces to the road or field ditch were built. This is the most called for type of baffle. Water emptying from terraces into a ditch cuts back along the terrace quickly and makes it necessary for something to be done.

Near El Reno, this had happened so bad in three years time that the grade of the terrace had to be changed and make the terrace empty above the ditch, in order to keep from building large concrete dams. This gorge at the end of each old terrace can be filled with straw and thoroughly filled up. The new outlets were protected by concrete drops before new ditches were made. One of these drops is six feet high, but most of them are about four feet.

I have built several baffles out of hard rock. These were built similar to cobblestone work. There is very little saving in cement over a plain concrete baffle. There is a little more saving in a large baffle than in a small one. The walls have to be made a little thicker when the cobblestone is used because it cannot be reinforced so easily.

Method of Building Baffles Without Forms

The best estimates I can make so far, from our experiments, is a saving of nearly one-third in cost of material and labor of baffles built without using any forms over the cost where forms are used. This is only an estimate of the amount; but we do know that there is a saving in both labor and material.

To build a baffle without the use of wood or metal forms, dig the hole where the baffle is to be with three sloping sides. If the ditch is already formed and is deeper than desired, the soil should be tamped in and the back wall smoothed off with a sloping side. This will appear then as though it had been dug out. Place a layer of heavy hog wire in the hole across the ditch and another layer lengthwise the ditch, making a double layer of hog wire to serve as reinforcing. Next place concrete on the sloping sides. Be sure to lift the wire up a little so that it is embedded in the concrete. The concrete should be about four inches thick. Tamp well. After the concrete is all in and shaped up fairly well with a trowel (do not trowel excessively) finish with a whisk broom and a mixture of cement and water, mixed to the consistency of paint. This gives an attractive finish and seals all pores. On the second day cover with soil or straw and wet down to cure.

The mixture of concrete to use in constructing baffles should be one part cement, two parts sand and three parts crushed rock or gravel: or if

sand and cement alone are used, use one part cement to three parts sand, using just enough water to make a stiff jelly like mixture so the concrete will lay on the sloping sides. We find the sides can be made very steep. But be sure to place the concrete on the sides first. If the bottom is placed first, tramping on it will cause the sides to slip.

There are still many faults being made in baffle construction. One is too small a water gap, many times only part of the available space is being used for the water gap. It is both easier to construct and a saving of material to let the water gap or throat extend full width between abutment walls. Another serious fault is leaving off the abutment or side protecting walls. This allows the water, flowing over the baffle, to wash the dirt from the lower side at the ends of the wall, thus allowing the baffle to be free to move down hill. Another fault or rather custom is that more material than necessary is being used, and complicated forms are being used in their construction.

With our limited time and knowledge of baffle construction we have not been able to do a great deal toward securing cooperation between farmer and county road officials. I have had the opportunity in a few cases to actually try out the plan of cooperation and in most cases found a willingness. The main work done along this line has been done by articles put in papers and discussing the plan at meetings. It seems to me that we must first get the public to thinking along this line and then work out an actual plan of cooperation. So far we have not been able to come to a definite plan that is fair to both farmer and road official. This will be worked out in due time.

At Sulphur, Oklahoma, I have just completed a series of tests on several types of baffles, using the water from the large Artesian well, about 3,000 gallons per minute. Although my experimental work is not complete, several facts have been found out.

The vertical drop for the water to fall over handles the water a little more efficiently, i. e., it is easier to check the velocity of the water at the bottom of the fall. By having the bottom apron of the baffle about eight inches below the bottom of the ditch and an eight inch riser on the apron just beyond where the falling water strikes the water glides away smoothly, but if the apron is the same level as the bottom of the ditch the water makes a short jump over this riser and has a slight cutting effect. Similar conditions exist with the inclined drop.

The test on the four foot inclined fall making the apron curve up about eight inches high caused the water to jump about five feet beyond the end of the apron. This is a very desirable result. The test on comparing two baffles with vertical drops, one having sloping abutment walls and the other vertical abutment walls was so near the same as far as handling the water that the type with vertical drop and sloping abutment walls will probably be used, because of ease and less cost of construction.

I shall not attempt to give results of all the tests, as I expect to run them again in a few weeks, in order to completely satisfy myself on the various facts.

SOIL EROSION

By

H. H. BENNETT, in Charge, Soil Erosion and Moisture Conservation Investigations

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Washington, D. C.

Doubtless, many of us have been considerably jolted by the enormity of soil wastage through erosion, as revealed by the erosion survey of Oklahoma. But we want the facts. Nothing is to be gained by concealing them.

Revision of our traditions: The time has arrived, as I conceive it, for a revision of the traditions upon which our system of land utilization has been based. Some of our time-honored conceptions relating to the permanency of the soil have recently been shown to have far less basis in fact than in theory—or, should we say, thoughtlessness. At one time the idea seemed to prevail in the minds of some students of soils and land economics, that the soil is our one indestructible, immutable vital natural resource. Even today we hear an occasional reflection of this point of view, and now and then a voice is lifted out of what seems to be a confused logic that erosion sometimes improves the washing land. It is probably true that isolated examples of infinitesimally small importance can be produced out of the infinity of soil variations to support these largely fallacious points of view. With these rare bits of meaningless evidence we are not presently concerned. Let us pause for a moment, however, to read part of an editorial which appared last winter in a publication devoted to popularizing science. Says the editorial:

> "The washing away of the soil may be a serious matter, undeniably, for the individual farmer whose fields are being damaged. There are a few counties, mostly in the southern states, where gullying and hillside scare amount to a community problem. All this is not hard to stop. The only necessities are careful and competent farmers, plus a little education."

The single thought that comes from statements of this kind is that not a little education is needed, but a vast amount of education, lest some unfortunate listeners should succumb to the narrowness of the conceptions of those who, having looked without seeing, are prone to speak askance of the grave seriousness of erosion. But I shall take no more time to discuss this isolated viewpoint, further than to say that it is an admirable illustration of how little the problem has been understood by some of us, and with what smirk complacency those knowing little or nothing about it continue to look upon its far-reaching depredations. The principal difficulty has been, of course, that we have mistakenly felt that Nature would take care of the situation, and have thought little about the matter. Most of us have been guilty. Now that we realize the gravity of our mistake, it is time to make amends, at least to try to do so.

Soil durability: It will do no harm to repeat now some of the essentials of our present-day conceptions concerning the permanency of the soil. The soil, a fragile material composed of the unconsolidated products of rock and organic decay, is one of the most changeable and easily disintegrable of our great natural resources, save those irreplaceable products, as petroleum and coal, whose principal use calls for their utter and almost instantaneous destruction. Lying exposed to rain, wind and weathering, the soil is subject to continuous change and removal. Under natural processes, nevertheless, an approximate balance is struck between soil formation from beneath and soil removal from above, in the greater part of the more humid regions at

any rate. If it were not so, if the soil under Nature's processes were subject to excessively rapid removal from above, this earth would now be, after eons of time, a snarled complex of canyons, badlands and land reduced to the lowly level of coastal marsh and inland morass. Under such conditions it is manifest the world would be incapable of supporting anything like its present population.

With the protection of a stabilizing cover of vegetation, the soil usually is a more or less permanent substance, at least as relating to time consciousness of an individual. Accordingly, we are not so concerned at the moment with what Nature is doing as with what man is doing to accentuate erosion by upsetting normal conditions.

Soil building: With his axes, picks, plows and grazing animals, man ruthlessly thrusts aside practically every natural or normal process relating to the permanency of the soil. He cuts away the trees, digs out the stumps and underground stitching of plant roots, and breaks down the soil-holding turf of the prairies; with his livestock he mows away the grasses and herbaceous growth of the expansive dry-land areas, and with his plows he disrupts absorptive pores of the soil and breaks up other exceedingly important structural characteristics that normally exist in the soil. When thus he has violently upset or destroyed these normal conditions, and when unrestrained rains have stripped thousands of fields down to raw clay or rock and ribboned countless slopes with hideous gullies, man has been in the habit of placing the blame upon the hands of Nature, and forgetting about it. This, of course, is merely an excuse, though possibly an unconscious one, and a simple comfortable way of condoning a sin against creation and posterity.

Soil removal: It is the soil that goes first under the attack of man-speeded washing. The top layer, that vital stratum of intimately mixed minerals and humus, the abiding place of incredible hosts of microscopic life, is the layer from which plants derive their principal sustenance. Beneath this surface layer, at depths usually not exceeding six, eight or 10 inches over the rolling uplands comprising not less than 75 per cent of all the land in cultivation in the United States today, lies subsurface and, in turn, subsoil material—not soil. The exposed subsoil is less productive and more difficult to till. It consists of material vastly different from that of the topsoil. Containing much less humus, which in a sense is the very life of the soil, this sub-layer is usually less absorptive and more erosive than was the soil now washed away. Crops can be grown on the raw material, but only at increased cost—a cost that grows as the upper material is planed off deeper and deeper.

For Nature to build an inch of topsoil of this kind such as we find, for example, in the seven-inch surface layer of the extensive Shelby loam in north central Missouri and southern Iowa, not less than 330 years are required, according to the way I interpret the results of the carefully conducted measurements of Miller, Duley and Krusekopf at the Missouri Agricultural Experiment Station. Here, the rate of soil removal by erosion from bluegrass sod was found to amount to a layer seven inches thick in 2320 years. I am convinced that under a good sod of bluegrass the washing proceeds at about the same rate as under any good natural cover. The time required in the region of the Shelby soils for the building of a single inch of the well-balanced, properly conditioned natural surface soil as mentioned seemingly is a minimum estimate. We have, as yet, found no way of getting at the maximum time required to build such a depth of normal soil. It may be a thousand years; no one knows.

Before turning from this thought, we might profitably reflect upon the time required under man-induced processes to remove the same precious

topsoil, which in the practical sense is to destroy it, at least insofar as involving a given eroded area.

The same measurements as those already referred to, made on the same type of soil, occupying the same slope, show that under continuous corn only 49 years are required to remove a seven-inch layer of topsoil. Other measurements on steeper slopes show that the rate proceeds much faster as the grade increases.

Even these measurements fail to give us a clear picture of their dismaying portent until we have looked closer into their meaning. The measurements that have been briefly referred to were made on land having about the average slope for the very extensive Shelby soils and some others of much the same character, such as the Clinton soils. The subsoil that lies beneath the rich dark surface of this type is a stiff yellow clay, which becomes hard and dry in summer, losing its moisture rapidly and presenting tillage difficulties by reason of its characteristic intractableness. In many fields the yields of corn have been reduced, as a result of erosional changes in the land, from 60 or 75 bushels an acre to around 20 bushels, and some years to almost nothing. The yield can be brought back considerably, though not to the averages of those fields which still have a fair covering of the original productive topsoil. With sweet clover, manure and fertilizer, it is generally conceded that fairly good yields can still be obtained from severely washed land of this kind. But here lies the crux of the problem: It costs to grow crops solely for the purpose of replenishing a depleted soil. It also costs to apply manure and fertilizer. Farmers are held in, bound by costs, some of them at any rate. The proof is seen in abandoned farms and farms largely turned over to grass in a region where the wish of nearly every farmer is to keep as much land in corn as profitably can be done. Corn growing in the Shelby soil region has diminished greatly on many eroded farms, giving way to grass and to livestock.

Meaning of the vital topsoil: When the Federal Farm Loan Bank of Houston, Texas, announced its policy of lending to farmers on the basis of the top six inches of soil representing the average upland farmer's principal capital, in the region served by that institution, a new economic principle of profound importance was brought to the fore. This definition is sound in every way, though wholly contradictory to the conception of numerous people about soil depth, which is that the soil goes on down to bedrock, or to the depths much below six, eight, 10 or 12-inch layers representing the usual thickness of our upland soils. Much subsoil farming is being carried on in this country today, and many of those doing it are unaware of the fact.

Destructive rains: Recently, it was announced that "a million dollar rain" fell in the section about Moultrie, Georgia. Crops suffering from a prolonged drouth were refreshed by the merciful downpour, renewing growth at a time when failure was dangerously near. At about the same time heavy rains fell all the way from Iowa, across Missouri, Kansas, Arkansas and Oklahoma into Texas. But these rains were not needed. The ground was moist and crops were getting nicely under way. A vast amount of destructive washing ensued. The ground was in that loose, freshly plowed condition that favors severe erosion.

It is impossible, of course, to figure the cost of these unneeded destructive rains. The cost of erosion, representing an account of accumulative depreciation, we are unable to put into terms of dollars the damage occasioned by unneeded downpours of the kind referred to. Notwithstanding this, we can make some estimates of the cost in a broadly inclusive way by taking into consideration both the immediate damage and the damage that may rightfully be charged against the accrued loss account, meaning the ratio of the depth of soil-removal to the total depth of topsoil.

I was in the region while these destructive rains were falling; I saw what happened, and using some of the data obtained at the experiment station at Temple, Texas, by Dr. George S. Musgrave, I was able to make some estimates which probably are not far from correct.

Take the Black Belt of Texas as an example, not because the washing was worse there than it was in a number of other regions, but because we happened to get some pertinent erosion figures for that region. A plot planted to cotton on typical Black Belt clay having a slope of soil about the average for the rolling part of the region, lost 17 tons per acre by the heavy rainfall of May 10. Applying half of this rate of soil loss to the large area of black land soil that was severely eroded during the rainy spell of this date and immediately before and afterward, I find that not less than 40 million tons of soil were washed off the slopes of this one region by this one rainy period, to be carried down the stream toward the Gulf of Mexico or deposited in depressions and over lower slopes, where the soil was already deep and rich, needing no additional deposits. When we came to consider the amount of soil material that was transported from the higher slopes to lower positions, but not all the way out of the fields, the figures quickly run almost beyond comprehension. Much cotton was bodily washed out of the ground and in many places the plants were covered to depths ranging up to a foot or more.

Forty million tons of soil, mostly rich, black surface soil of the splendid type we call Houston black clay, is a big loss. The farmers of today will not have to foot the bill immediately, although many of them will lose heavily this year, as the result of this wastage and again next year and so on; and their children, if they still own the land when all the surface layer is gone, will be paying for this and other destructive rains that fell before, and still others yet to fall, many years to come, unless vastly more is done to control erosion in this region, and done quickly.

On the basis of the cheapest fertilizers obtainable, the plant food and the valuable disintegrated humus contained in 40 million tons of soil of this kind has a potential value of probably not less than $30,000,000. We are unable, with the available data, to calculate in dollars the immediate or tangible losses. Our studies in this direction are still too immature for this; though we know that neither the Black Belt nor any other eroding region having a limited soil depth can withstand such losses indefinitely. Much of the land of this section has been in cultivation only about 35 to 50 years. Already, many thousands of acres have lost all of their extraordinary fertile black soil down to yellow clay, and other thousands of acres have lost both the black soil and the yellow-brown subsoil, down to white chalk or marl. When I was surveying soils in central Texas 23 years ago, the Black Belt was a true black belt, with the white and yellow spots largely restricted to the steepest slopes. Now, the rolling parts of the area, comprising more than half of this region of approximately 11 million acres is a mixed black, yellow and white belt. Continuation of present methods of land utilization will surely change the area to a vastly less productive yellow and white belt, with black strips along the stream courses. This is not a prediction, but a physical certainty, determined by the depth of soil and rate of soil removal.

Thus, while the Georgia area was having a million dollar beneficial rain, Texas was suffering from a 30 million dollar rain, with its effects all on the wrong side of the ledger. And these destructive rains were by no means confined to the Lone Star State. They were similarly destructive over the rolling Red Plains of Oklahoma, and wrought tremendous damage in northern Missouri and southern Iowa.

Erosion and floods in the dry Southwest: About six weeks ago, I made a reconnoissance of erosion conditions in the upper Rio Grande Valley in

New Mexico. The Bureau of Chemistry and Soils made last year in this region a very accurate survey of the alluvial soils along the Rio Grande from the head of Elephant Butte Reservoir to the mouth of the Puerco river. Following the completion of this survey, a disastrous flood swept down the Rio Grande in August and September, 1929. Sediments from the overflow so changed the character of the soils that most of the alluvial area had to be resurveyed this year. Soils that were mapped as clay last year were covered with lose sand to depths varying from about a foot to more than three feet. Conversely, sands were deeply covered with clay. In places, near the head of the reservoir, sand deposits seven feet deep were found. The towns of San Marcial and San Acacia were destroyed; numerous farmhouses, schools and churches were wrecked; the inhabitants were forced to flee to the hills for their lives. Tremendous damage was done to the tracks, fills and bridges of the Santa Fe Railway. The indications are that no such flood ever before came down the Rio Grande either in historic or prehistoric time. Preliminary estimates based on the depth of alluvial deposits found over an area of approximately a hundred square miles indicate that enough sand, silt and clay were laid down by this one flood over a 40-mile strip of the alluvial plain to build a monolith having a cross-section of the dimensions of an acre and a height of more than eight miles. Nearly 100 million tons of sediments came to rest over the 40-mile strip of river bottom surveyed.

We do not know yet how much material entered in the 35 mile length of water impounded by the Elephant Butte dam, our greatest irrigation reservoir. Previous estimates have shown that approximately 20 thousand acre-feet of sediments find their way into this important reservoir every year, the accumulation thus far being enough, I am informed, to cover every acre irrigated by this project to a depth of two feet. With sand piles ranging up to seven feet deep near the head of the water, the deposition in the reservoir must have been enormous.

Thus, erosion does not stop with merely denuding the uplands of their lifegiving topsoil. Its products go on to fill reservoirs, irrigation ditches, stream channels and harbors; and to cover valuable alluvial lands, highways and culverts.

A large proportion of the sediments of this flood came down the Puerco river. I went up the valley of this stream for a distance of some 65 miles above Albuquerque. In all that distance not so much as an acre of what was considered original soil could be found along the slopes, although we searched even the cemeteries. Here the world is on the move. Erosion, resulting from overgrazing, has swept away the soil, and with it has gone most of the better grasses and nutritious herbaceous plants, representing the grazing assets of the region, its principal resource. Large pines were found in the foothills where the long lateral roots have been completely exposed, the trees depending on tap-roots that have wedged deeply between the rocks for their sustenance. All the soils are highly erosive. Some types derived from fine-grained sandstone and shale are as susceptible to washing as anything I ever saw.

Destruction of the lands of the Pueblos: Even the alluvial plains along the Puerco and its tributaries have been deeply incised by broad channels. In places the entire alluvial bed has been swept out from the foot of the hills on one side of the valley to the foot of the hills on the opposite side. At one place, a village has already partly toppled into the deep, widening trench of the Puerco, which at this point has a depth of about 50 feet.

All this devastation has taken place since the coming of white men to the region about 45 years ago, with his sheep, goats and cattle. At this time, as we are told by the old settlers, the Puerco and the other similar regional streams had no channels. The alluvial plain, formed of slowly ac-

cumulated wash from the hills and mountains, was a series of well grassed vegas, over which flood water spread out and largely seeped into the deep, pervious soil, doing no damage. It was on these alluvial plains that the Pueblos carried on their agricultural operations prior to the advent of white men.

In places, drifting sand dunes were found where formerly was good grazing ground. Such spectacles are remindful of the advance of the merciless Gobi Desert over areas that once were inhabited by man.

In this region and throughout most of the dry-land grazing areas of the Southwest, the balance between soil and vegetation is about as delicately fixed as the hairspring of a fine watch. Removal of the stabilizing plants and destruction of soil structure by trampling of stock starts up devastating erosion and causes increased runoff from the dashing rains of the wet season. The alluvial plains, incapable of withstanding the increased volume of water rushing down upon them, give away to the onslaught. Canyons are chiseled out of cattle trails and roadways. The work of untold centuries of soil development is rudely destroyed.

Present practice encourages overgrazing: And so it is in thousands of localities throughout the vast expanses of grazing country occupied by our public domain and associated, interlocking privately owned land, state land, Indian reservations and so on. Land misuse is written over the face of the earth. Stark evidence of range impairment and destruction by erosion is seen nearly everywhere, except in localities without water, occasional protected areas and over certain peculiar stony lands. Our system of land utilization in these expansive areas has encouraged overgrazing and consequent destructive washing and increased difficulties of vegetative restoral. If a rancher on the public domain should regulate his grazing practice so as to encourage restoration or conservation of the native range forage, his neighbor's stock would likely share in the grazing and give trouble by intermingling of herds. I am told that the public domain cannot be fenced. Under such circumstances, it is impossible, of course, for a rancher to protect his range.

The cost: Unless measures are taken on a far-reaching scale to slow down and prevent as much as possible of this tremendous wastage by erosion, the time surely will come when vast areas of our farm lands will be stripped of their more productive surface soil, and other huge areas will be so gullied as to render them unavailable for profitable farming, even when prices are good. Again, let me say, please, that this is not a mere prediction, but an obvious physical eventuality. I am not insisting that we are about to run short of farm land. It has been pointed out that for a considerable time to come, we shall probably have sufficient land to take care of our increasing population. We shall doubtless continue to produce abundantly for a considerable while yet, even though we may not always produce profitably.

The point that we are presently concerned with most, according to my observations and field studies of the Nation's varying soils during the past quarter of a century, is not a threatening land shortage, but a shortage of good farm land. The latter state of affairs may come sooner than we have generally expected. The Oklahoma erosion survey is the only further evidence that I shall point to in this connection, at this time. Thirteen million acres of the 16 million acres in cultivation in this new agricultural state suffering from erosion, with nearly six million acres of the damaged land already gullied in some degree, is, perhaps, a sufficiently glittering example to illustrate the cost of erosion.

Temporary maintenance of yields does not stop erosion: Soil washing is cutting steadily into the areas of the better lands in many parts of the country, ruining much and impoverishing millions of acres. With numerous farmers the seriousness of erosion is not a threat of the future, but a

present evil. Many of these, operating on erosion-enfeebled land, are finding it impossible to make more than the barest living. Yields are being maintained in many parts of the country by means of increased labor-saving machinery, fertilizers, soil improving crops and better breeds of livestock, and, of course, by turning to the better remaining acres of land. Such fair to good yields may stand up fairly well for years. At the same time, we must not forget, that the yields in many areas are diminishing. Machinery does not stop soil washing; neither does the turning out of poor land for land which has not yet lost its topsoil stop the wasteful process. We must ascertain through experimentation in the more erosive soil regions those cropping methods and practical engineering structures which will prevent as much of the washings as may be possible. Delay means accumulated evils and often increased rates of erosion. In a sense, we are nearing the end of an era in our methods of land utilization, at least, it is to be hoped that we are and also that we are at the beginning of another era—one in which we must strive with all our resources to conserve our better lands. If we do not save, we cannot produce, not with economic efficiency at any rate. We cannot afford to depend upon other nations for our staples of life. With the advancement of sanitation and medical science, we may expect to see rapid population increases in those countries where there yet remain available areas of good agricultural lands; and these other countries may, in the not distant future, need their better lands for their own use. Let us not forget that all the countries of the world do not have within their boundaries available areas of good land. Indeed, some large regions have neither good land nor mediocre land, the soil having largely washed away many ages ago.

Our attitude toward this new era of better soil protection will be one of optimism and unceasing striving for better things. Whatever tangible results accrue from our efforts, you may be assured that not only will posterity be thankful, but a large number of farmers now struggling for existence on land that should be in trees or grass, or held as grazing reserves, will be materially benefitted.

A new era of soil conservation: If this were not a new era, as pertaining to better use of our agricultural soils—that use which concerns itself with the preservation of the soil capital, as the Federal Land Bank at Houston has construed soil capital—we would not be gathered here in this second annual meeting of the Southwest Soil and Water Conservation Conference. Did you ever hear of any such thing before the first Conference of this same kind was held in Texas last year? Of course not. No such conference or meeting was ever held before. We had had conferences in which the subject of soil conservation was a part of the discussions, to be sure; but never one where the subject was the whole sum and substance of the meeting—a meeting where experienced agriculturalists, soil scientists and engineers came together to discuss an actual going program relating to the full scope of this phase of conservation.

Gentlemen, we are now actually engaged in battle and we are beginning to get results, as Mr. S. W. Phillips, in charge of the work of the Bureau of Chemistry and Soils at the Guthrie Soil Erosion and Moisture Conservation Experiment Station, and others, have pointed out today. Erosion is the biggest problem relating to the physical side of crop production. To stop it, even to slow it down in a far-reaching way, is going to be a hard, prolonged fight. Surely the men engaged in this fight should be proud of their enlistment. It is a fight, not for acquisition of new territory, but for holding safely the territory we already command. We are undertaking to maneuver our armies of agriculturists around the sinister enemy of subsoil farming and all the iniquities that kind of farming breeds.

In these efforts at devising ways and means for conserving the fertility of our agricultural lands, we are striving to get at the fundamentals of a

process which is more powerful than all the other combined agencies that affect the soil. I mean soil erosion intensified and accentuated by the intervention of man. Much remains to be learned. Who would ever have supposed a few years back that one rain would sweep from the average slope of the Black Belt of Texas 17 tons of soil per acre, or from an eight per cent slope in the Red Plains region of Oklahoma, 12 tons per acre? We are, perhaps, farther behind in this branch of agricultural experimental work than in any other having to do so intimately and vitally with the welfare of man. Hosts of facts remain to be garnered from the realm of the unknown in this field of research and experimentation, such as the major causes of organic losses from our soils, precise measurements of runoff and washoff from fields and watersheds covered by varying soils and vegetation and undergoing varying treatments under differing climatic environments. We shall perhaps never know, for example, the full significance of these natural and induced variants in their relation to floods derived from watersheds existing under conditions of soil norms and under conditions where these norms have been profoundly disturbed, until carefully surveyed normal areas encompassing one definite group of variants are compared with the same kind of areas where the variants have been radically disturbed. But we propose to get these data. They are vitally needed. We are going to break away from the traditions. We have already started, knowing that we cannot afford to use our agricultural lands with the idea that the soil is a fixed thing, a substance that Nature will care for. Vast areas stripped of their soil down to unproductive subsoil, and the latter riddled with gullies, means, of course, that in the past we have failed to take care of our most important God-given asset. We must check the advance or confess that the enemy is winning, and that our part is to be an empty shell. Those fighters in this war on erosional wastage who keep always in the foreground of their striving the main objective—the prevention of as much as possible of this national soil deterioration and its attendant demoralization and disintegration of agricultural economics on thousands of farmsteads—are the kind of soldiers of which the cause is most in need. And the present time with overproduction from good farm land and from poor farm land, with the evils that follow in the wake of overproduction, is the very time for redoubling our efforts to save the good land and to put the marginal areas back into timber or grass or to hold them as grazing reserves.

THE TEXAS EXTENSION PROGRAM IN SOIL CONSERVATION AND RESULTS

By

O. B. MARTIN, Director of Extension

College Station, Texas

The first thing on the program this morning is the Texas Extension program and its results. Following the meeting of the Southwest Association at College Station last year we appointed a committe of which Mr. A. K. Short is chairman. This committee had a report ready by August 1 which was presented to our Texas Agricultural Workers Association in session at College Station. This report gave the objectives and relationship and outlined the duties of the various bodies taking part in the extension service, experiment service, forest service, chambers of commerce, Federal Land Bank of Houston, joint stock land banks and other land loan agencies, railroad agricultural agents, the press, educational agencies of commercial concerns, implement agencies and local dealers and commissioners' court. Our state committee has been active throughout the year. It soon, however, will be making its report. We have prepared some material of this kind for advertising purposes. I have a large number of stickers here on the table suitable for use in office or home and have sizes for auto windshields as well as for other such uses. You can find these distributed all over the state of Texas.

County conferences were arranged in various places in which these agencies all took part. I recall one of the first of these conferences held at Bergheim in Washington county which happened to be the home of Mr. Buchanan who is the candidate on the general committee on appropriations in the House of Representatives in Congress. He has had a large share in getting appropriations through for agricultural work in the U. S. D. A. and colleges. Mr. Buchanan sat with that conference all the time. It was just a small conference during the day and then a public meeting at night. He sat with the committee and took great interest in the discussions. The business people took part in a great many of these meetings. The Texas schools went right along with the meeting. I am not going to take your time to go into detail because there are other representatives in Texas better qualified to speak than I am.

Before we take on any more speakers, I want to introduce Mother and Father Bentley. They can stand up and let us all see them and we can take time out now and go around and shake hands with them. Their son and daughter-in-law are also in the audience and we can go around and shake hands with them also.

THE TEXAS EXTENSION PROGRAM IN SOIL CONSERVATION AND RESULTS

By
M. R. BENTLEY, Agricultural Engineer
Texas Agricultural and Mechanical College

When we give figures about Texas you may think that they are a little large, but the same wind that comes down across western Kansas comes on across Texas and covers lots more territory when it blows across Texas. We undertook to get a recent survey of the extension work in Texas the past 12 months from June, 1929 to June, 1930. Through some negligence on our part we did not get all of the reports in. We got 100 of them, but we have 150 counties which report terracing. We have something like 170 county agents, but 20 of them carry on no terracing work. I have taken that 100 and added 50% to it. I think that is fair because we got 150 reports last year.

The first question asked was the number of acres terraced or contoured. When the lines on the land are laid off with an instrument, and then followed, but no terraces built, we call it contoured. That is done in west Texas on the comparatively level land. The number of acres terraced or contoured was 867,000. The number of men who learned to run terrace lines was 4,774. Then we wanted to show that the boys were taking part in this, so we asked how many boys assisted with terrace surveying, and found that there were 3,307. There were 814 farm levels purchased, and 940 terracers, other than terracing plows, bought. These plows, too, have been selling pretty good this past year. We think it is a good thing, because it allows a small farmer to terrace his field without the expense of large machinery. There were 448 of these terracing plows bought. This is a walking plow with a long wing. About 10 years ago they could hardly be sold at all. Last year we held 1,405 terracing schools. We have worked on the terracing school business. We try to teach the farmers to run their own lines. Another thing we have tried to do is to get the county commissioners interested in terracing. We are interested in getting our land terraced, but we are more interested in getting the county commissioners to study this terracing business.

Last year 64 counties put from one to four of their big outfits out to terracing the land. Then we got to wondering about our figures in Texas on the total amount terraced, so the first of this year I made a survey of that. It checked very closely with the records that we had, and we found out another thing that we did not know. Of the 254 counties in Texas there is some terracing in 202 of them, not counting the counties which have only rice levees or borders for irrigation. Of the total estimated acreage (867,000) terraced or contoured, not over 200,000 acres are contoured without terraces, leaving 667,000 acres terraced between June, 1929 and June, 1930. The figures that we got for 1929 (up to January 1, 1929) show 609,055 acres terraced or contoured during the year. Thus there was an increase in 1930. A recheck made recently showed that a total of 3,689,000 acres had been terraced or contoured up to January 1, 1930, in Texas. Ralls county has the most terracing, with Jones county coming second.

Some folks have been wondering if we could terrace enough land to stop overflow of the rivers. We can not even make an estimate of what will happen when all of this land is terraced.

Doctor Bennett took a knock at our black land of Texas, and we deserve it. I took five of the black land counties and the average this year was 3,500 acres terraced. Then I took five of the best ones out in west Texas

where they do not need terracing, so they say, and found 35,000 acres terraced. Thus they are more interested in west Texas in conserving water than in conserving soil. This land will eventually all be terraced. They need some terraces even if the land is fairly level. One reason is that when they change from a row crop to a grain crop they lose the survey of the land if it is not terraced. Then, when we get big rains we need terraces to catch the water.

We do not have so much pride in these big acreages for there is much to be done yet. We did not at first count on terracing west Texas. One thing we have pride in is the contouring of the rows. My estimate is that on 90% of the terraced land the rows follow the terrace. We have worked pretty hard on that. Last year some engineer told us we could not use big machinery on these crooked rows, but he did not discourage us. We still believe just as strongly as ever that contoured rows are important. The benefit of terraces is just to stop ditches and gullies, and if we do not run with them we lose much of the value of terracing. You know the kind of machinery that we use in Texas, not the double shovel, but it is about as big machinery as in any state, and we go right down those crooked rows. The farmers are strong in their arguments for contour farming.

L. A. JONES, U. S. D. A.:

Two weeks ago I went over the records of the lands terraced. There is a total of 1,680,000 acres from the year of 1929. Of that amount Texas had 600,000 acres, or a little more than ⅓ of the total acreage terraced.

Another thing that will interest this group is the fact that we succeeded in getting a question in the 1930 census asking the number of acres terraced, and probably by another year we should have a pretty accurate estimate of the number of acres terraced.

EXTENSION PROGRAM IN BOWIE COUNTY, TEXAS

By

W. R. HOLSEY, County Agent, Bowie County

I want to tell you how we are going at the terracing job in northeast Texas. It is a tremendous problem to conserve the soil of the entire southwest but we have got to do it. An impoverished soil means an impoverished people. The Extension Service can do no greater work than to conserve our soil for this and succeeding generations. I came here to get information from the men who are covering the southwest.

In our county the land is sandy. The county is about 40 miles long and 30 miles wide. It has some timber and has been in cultivation from 50 to 100 years. Ten years ago when I came to the county there were only 10 or 12 farms terraced. I conceived the idea from reports on terraces that a terrace 25 to 45 feet wide and about two feet high would last longer and give better results if we could get such a terrace built. If the terrace is built eight feet wide, the farmer will let weeds grow on it and will tear it down.

We now have more than 1600 farms terraced with this kind of terrace. It has proved to be an economical way to put the job over. The people of the county are sold on the value of terracing.

We also suggest that the farmer contour the rows so far as possible. We do not recommend contouring so that there are short rows in the middle of the field. Instead angle over the terraces if necessary. This is working in my county.

We find we can build terraces with the Kelly plow. With four horses or mules, a terrace can be thrown up by going over them about three times. Then after a rain go over them again. Use a fresno to make the fills.

I know that the gradient must be adapted to the different rainfall. In our county we use about three to four inches fall in 100 feet and about three feet vertical height. It is possible that less fall would be wanted in the drier sections.

T. B. LEWIS, Texas:

As the outgrowth of a controversy over turning the water from terraces into the roads, we have a county committee with the county judge as chairman and the county commissioners as precinct chairmen. When a man wants terracing done he goes to the county judge.

We have several county graders busy from September to March or April. They are caterpillars ranging in size from three to 10 tons. There are also five or six individuals who are doing work with their own tractors. Probably some large land owners will buy more tractors this year.

We are cultivating quite a bit of terraced land now, running the rows with the terrace or on the contour.

THE MISSOURI EXTENSION PROGRAM IN SOIL CONSERVATION AND RESULTS

By
M. F. MILLER, Assistant Dean
School of Agriculture, University of Missouri

The program of extension in Missouri has not gone very far. We have in our extension service a soils and crops program which has gone pretty well in its clover and prosperity campaign. It has been quite effective. We talk, not only crop rotations and growing legumes, but everything that goes with it—liming and fertilizing, and also the matter of erosion control. For a great many years we have been carrying on through this medium, erosion control from that standpoint. However, it has not been given a great deal of attention though the erosion control factor is outstanding in the general program.

In addition to that we have in the extension service men who go out and teach or put on demonstrations in terracing. This has been going on now for some time, and it is this phase of the work in our state which constitutes our program.

Some time ago we had a conference of the various men interested in erosion control, and decided that hereafter our demonstrations in erosion control would be of general erosion control and not terracing demonstrations alone. You must remember that when you get into states like Missouri and the other corn belt states you have quite a different problem from what you have in the states farther south. In the first place we grow general crops, but corn is our specialty. The cropping system is the thing which is important with us. In some of your states you grow great acreages of cotton. Cotton is a high priced crop. If the land is not maintained like it should be, they fertilize the land and cotton will stand lots of fertilizer. In the corn belts you can not use as much fertilizer because corn is a cheap crop. Therefore, we must cut down on our fertilizer usage. We use quite a little fertilizer, of course, but nothing like you can with the higher priced crops of the southern states. Therefore, it is necessary for us to be very careful that our farmers are taught good cropping systems.

Our plan of erosion control is based on a general program of soil management—a well rounded program of soil management. We believe that this is best for us. As I say, our conditions are quite different from what you have, and we look at it quite differently from what you do. Terracing is a thing which lends itself well to extension work because it is spectacular. However, you must be careful in regions where agriculture is diversified not to over-emphasize any one thing. A good many years ago our extension service talked silos. That was a very tangible thing to get hold of, and to talk to the farmers. Silos were built on many, many farms and today I should say that over half of those silos are empty. In other words, we overdid that thing. It is perfectly easy to overdo in our state anything which is spectacular.

We do not know enough about terracing in the State of Missouri to go out and recommend it without qualifications. We know that there are soils that will respond well to terracing, but we have a lot to learn. We believe we will find out from our new farm a lot of things we do not know now. We are inclined to be conservative. It is very difficult to get our farmers to do things which they should do unless we do put on a very spectacular campaign, and we are a little afraid of spectacular campaigns. A well rounded program goes much more slowly with these conservative farmers.

I have been in this work too long to let that worry me. I know well enough that after all is said and done, it is only a comparatively small per cent of the farmers who will do the things we recommend.

In Missouri we have three classes of farmers:

(1) Those who will do everything that the experiment station recommends—the sweet clover farmers.

(2) Those who will do part of the things you tell them to do but not everything—the soy bean farmers.

(3) Those who won't do anything you tell them to—the timothy hay farmers.

Our business is to get as many men to move from the second class to the first as possible, and to get as many to move from the third to the second as possible. We can never hope to get men to move from the third group to the first group.

We feel that our program should be a well rounded program in which all of these things have a part—cropping systems, the use of all sorts and types of soil saving dams, terraces where they can be used, and all that sort of thing. I sometimes make this statement, that any man can control the erosion on his farm is he wants to. We have German farmers in that state who have no erosion on their farms. They get the little gullies when they first start. Those men are thrifty, careful farmers, but we have a great group of farmers who are not in that class.

We have a great erosion problem but we are of the opinion that the erosion control program which we put out in a state like the State of Missouri should be a well rounded program.

THE KANSAS EXTENSION PROGRAM IN SOIL CONSERVATION AND RESULTS

By

DR. F. L. DULEY

Kansas Experiment Station

I am sorry our extension man could not be here today to discuss this program. I really have very little to do with it directly but have attempted to keep in as close touch with our extension division as possible. In Kansas, we think that for the present we need to proceed with a great deal of care in our program until we know a great deal more about terracing. Other methods of control of erosion have not been taken as seriously in Kansas as we would like. We are trying to proceed with demonstrations and we are trying to find out what really can be accomplished. We have a lot of soils in Kansas that are very difficult to terrace and are difficult to control by any method, and we do not feel that we know just what is the best method. We have a lot to learn about it. We hope that we can get information on this point within the next few years.

For instance, no one knows how to terrace our brown loose soils in the northeastern part of the state to prevent erosion. The fact is that it is not being prevented. We need a lot more information on that part of the state. We are trying to get that. I don't know how much you folks have thought about it but it has been my observation and Professor Miller mentioned much of the same thing, that terracing has never gone over in the corn belt as it has in the south. We have been holding terracing demonstrations in parts of the corn belt for a good while, 10 to 15 years, but in practically all states in that region terracing hasn't gone over as it has in the south. Part of that is due to some of the things which Mr. Miller mentioned. He mentioned that corn farmers have been able to get by with erosion and water loss and still get fair crops of corn.

One thing that we are doing in Kansas in our erosion program is carrying an agricultural engineer who does the terracing and goes along with the men, and also presides at the legume programs and usually goes and holds meetings where we emphasize particularly alfalfa and other legumes. On top of that we put on terracing demonstrations and talk terracing, trying to do it along with what we have to say about cropping systems. It is our opinion that a good cropping system is by far the most important thing that can be done to control erosion in our state. We feel that it is the most fundamental thing about the control of erosion.

We do not put terracing as the most important control of erosion. Certainly we should not for Kansas. I think the cropping system is far more important but terracing may be the first step. I think perhaps that we want to put one thing over at a time and follow it right up with a better cropping system and better rotations which will tend to hold the soil where it belongs after it has been terraced. This is the best scheme. It will probably work out better so far as the extension program is concerned.

We have been a little cautious on this thing until we get more information. Our experiments would indicate that terracing as such could hardly be depended upon as a preventative to erosion. Take the figures which Professor Miller presented on the amount of soil lost on those plats in Missouri. However, the length of those plats is less than the distance between those terraces. If you consider those losses as significant or serious, then perhaps the loss from one terrace to the next will be about as great as on those plots unless precaution is taken. We should watch the crop-

ping system and have cropping systems that will hold the soil right where it is and make the soil take in the rainfall or we must use certain mechanical methods. Our farmers are not doing this. We have not been able to put that idea over at all. That is, a method of mechanical means simply of keeping the water distributed over the surface of the hill side. That along with terracing may be a very effective means of controlling this erosion problem.

Another thing that we are trying to stay away from in Kansas is that some of our farmers will not use terracing as a means of stopping erosion but simply as an excuse for cropping their land harder. We had much rather they would run in some of the other crops like our better legumes and let them go along with the terracing and not let terracing be an excuse to crop the land harder.

We have increased the number of terraces in Kansas this year. Over 100 demonstrations have been put on already this spring. That very greatly increases the number now in the counties. We are trying to work out this program from these demonstrations and I feel that we are making some headway but the work is not as far along as that which some of you people report in your state. At the present time Kansas has only about 10,000 acres of terracing. There are only a few farmers who have gone out and terraced their land. This amount of land represents one-tenth of one percent of the land which we think ought to be terraced. Our programs call for doubling this amount this year. We have had terracing demonstrations in 32 counties. There are 32 sets of farm owned levels for laying out demonstrations. We are having schools in terracing to teach farmers how to terrace their land. I believe that Kansas is just at the place where we can make very rapid strides in this erosion program from now on. I believe that we are going to accomplish a great deal.

There was one other phase of erosion which I mentioned yesterday and a number of men have asked me why I did not say more about it and that is wind erosion. A number of years ago, there was great agitation throughout the dryland section of the United States to clean cultivate land or to use dust mulch. At first they wanted to keep the soil in a very fine condition. It was widely recommended as a means of growing wheat. That was what ruined us. Some of our western Kansas country just literally blew away. The soil is just in the condition to plow when it is in a fine condition. We found two or three fundamental things in controlling wind erosion.

1. Keep crops on the land. Keep the wheat long enough in the fall to keep the wind from blowing the soil.

2. Keep the land rough. Never keep it smooth. And finally, use various implements for doing that. We use Duck foot cultivators and one-way discs or angle plows as they are sometimes called to keep the land ridged. This one-way disc usually leaves the ground with straw and trash on the surface. This prevents very greatly the blowing of the soil. On some occasions these things do not completely control wind erosion. It is sometimes necessary to break the land still further. Putting manure on the land is good, but a more common method is to use a lister. These lister furrows will tend to stop the wind erosion. Sometimes you might think that it will tear up the whole wheat crop. It may do a lot of damage but you may go and turn the furrows back and usually it does not do a great deal of damage. These are the essential things about controlling wind erosion. This is one of the important things which is being emphasized in our wheat program for the western part of the state.

THE LOUISIANA EXTENSION PROGRAM IN SOIL CONSERVATION AND RESULTS

By
W. B. MERCIER, Director of Extension
Louisiana

Possibly Louisiana comes nearer having an acute soil and water problem on every farm than any other state represented at this conference. The handling of surplus water on the various alluvial or river bottom areas is a serious as well as most difficult and expensive problem in soil conservation and water control. Without proper drainage, thousands of acres of our most fertile lands are as worthless so far as profitable crop production is concerned, as the great washed off areas in the hill sections of the state. For this reason, our agricultural engineers have in addition to their terracing program one of drainage as well.

Since our meeting last year, we have been able to secure the services of a full-time Extension Agricultural Engineer. Naturally, it has taken a good deal of the time since his employment to make contacts and surveys sufficient to intelligently develop a comprehensive plan of work. After a careful investigation, it was decided to confine the present program to four divisions or phases: 1. Terracing and drainage; 2. Home conveniences; 3. Farm buildings; 4. Farm machinery. Other projects will be added to the program as needed.

The county agents and specialists were unable to organize as intensive a campaign in terracing last fall as was hoped for, but have already made arrangements to start early this fall and put on the most extensive and complete terracing drive that we have ever had in the state.

During the fall, winter, and early spring, the Engineering Specialist in cooperation with the Agronomy Specialist conducted a number of schools in soil conservation and improvement. These were well attended and opened the way for many more such meetings the coming fall.

A brief summary of the 1929 soil improvement work as reported by county agents is as follows:

Number of farms installing drainage systems	264
(a) Open ditches	162
(b) Under drains	102
(c) Acres drained by:	
1. Open ditches	17,808
2. Under drains	3,011
Number of farms installing irrigation systems	15
(a) Acres irrigated	124
Number of farms controlling erosion by terraces	2,486
by soil-improving dams	34
(a) Acres on which terraces were used	86,331
(b) Acres on which soil-improving dams were used	480
Number of farms clearing land of stumps	255
(a) Acres of land cleared	4,96[illegible]

THE ARKANSAS EXTENSION PROGRAM

By

W. J. BURLESON

University of Arkansas

I believe this is called a conference on conservation of soil and water, and we have injected wind into it also. I believe Kansas is getting away with a great deal of its wind and it is spreading over Texas. Arkansas is a little like Louisiana, and we have been getting a whole lot too much water not only from the states represented at this conference, but from some other states, so we do hope you will conserve your water and not send so much of it down to Arkansas.

The question of soil erosion is not so important in the delta section, and there has not been much terracing done, but in the cotton country of the hill sections terracing is becoming an important part of the extension program. The trouble is keeping it from becoming too important in the county agents' programs; keeping it from becoming too much of a personal service to farmers. For that reason we try to have the work so organized that terracing schools can be held in different parts of the state.

I was very much interested in the report of Mr. Holsey from a county in northeast Texas, because that county is very similar to a great many of Arkansas' counties. We are doing a great deal of work similar to the work Mr. Holsey is doing in Texas. We are trying to get the county agents to train certain local leaders in terracing. A great deal of progress is being made in some of the counties where terracing is badly needed. A great many counties are getting levels. Many of the counties devote some money for levels and turn them over to the county agents. Sometimes these levels are bought through the bankers.

Another way that interest is being stimulated in Arkansas in terracing work is in connection with our Farmers' Week at the University. We have a big Farmers' Week in August and a big attendance, and we put on contests with our 4-H club boys. That of course is directed by Professor Carter, who is agricultural engineer for the college. Some prizes are worked up for those who win in these contests.

THE OKLAHOMA EXTENSION PROGRAM IN SOIL CONSERVATION AND RESULTS

By

E. E. SCHOLL, Assistant Director of Extension

Oklahoma Agricultural and Mechanical College

In our soil conservation program we try to show the farmers of this state that they are simply custodians of the soil for the time being, and that they should make some effort to return that land to their children in as good a state as it was when they took it over. By approaching the subject in that way we receive a better response and get a better attitude towards the terracing work.

As in some of the other states, the farm engineer has several lines of work to do, but I am only going to touch upon that phase of the work which pertains to terracing or to the soil conservation phase of it. We have the feature of moisture conservation to be considered in Oklahoma, especially in the western part of the state, and it does receive quite a little attention.

Possibly the first terracing in Oklahoma was done in Carter and Love counties in about 1916, by A. G. Graham, the county agent of the above two counties. Mr. Graham is now in Mississippi, but has a son in Extension Work in Cleveland county, Oklahoma, where he is carrying out a successful soil conservation and improvement program.

On September 30, 1918, Maurice R. Bentley, son of W. D. Bentley, Father of Extension Work of Oklahoma, became the first farm engineer of this state. His report shows that in 1919, 38 terracing demonstrations were conducted in 21 Oklahoma counties with an average cost of $2.75 per acre, and the average estimated benefit of $15.00 per acre.

Mr. Bentley resigned in June of 1920, and has since that time conducted a constructive program in Texas.

Our next extension engineer was W. H. McPheeters who worked with our county agents from the fall of 1920 until June, 1925. A few months later this vacancy was filled by G. E. Martin of Texas, who is leaving us today to give his services to our neighboring state, Missouri.

The above three men have given the soil improvement program of Oklahoma great stimuli, and it is going to be exceedingly hard to find a sufficient number of men to fill the great demand for constructive work this year.

A great deal of the early efforts of our engineers was in the form of personal service, but as the demand for soil conservation increased, most of our county agents received instructions in terracing so that the acreage thus treated increased very rapidly. In addition to the assistance given the county agents, the farm engineers instructed farmers and their sons, so that at the present time it is possible to find men in practically every county of the state who can run terrace lines and give method demonstrations in this work. To this group of trained leaders should be added the large number of college graduates who are now in county agent and vocational agriculture work and who received special training in farm engineering here at the college.

Although the Extension workers have gone ahead with their work in practically every one of the 77 counties of Oklahoma and thousands of acres have been successfully terraced, the work is yet in its infancy and much more is to be done. We consider ourselves fortunate in having the Federal Research Work in Logan county, and also definite experiments here on the Station grounds on the subject of soil conservation, which will give us a great deal of information that will strengthen our program.

The information gathered by Dr. N. E. Winters in his soil erosion survey of 48 counties of Oklahoma will be a great help to us in our work. It certainly shows the great need of unifying our efforts and the necessity of arousing the folks of this country as brought out by Director Martin's talk yesterday.

In the line of achievements, I wish to quote the following from Farm Engineer G. E. Martin's report for 1929:

"Much prograss in the way of aroused public sentiment and in promoting the educational features of extension effort in terracing work has already been made. The quality of the work done by individual farmers over the state under extension leadership is steadily advancing, and terrace failure due to poor construction is decreasing. It is no longer possible to accurately estimate the number of acres terraced in Oklahoma in any one year, in fact acres terraced is subordinate to individuals trained, as a measuring stick of progress made in this work. July 1, 1929, Mr. C. V. Phagan joined the staff of Extension Forces as Assistant Specialist in Agricultural Engineering.

"November 1, 1929, a state-wide Soil Conservation Conference was held in the State Capitol at Oklahoma City which aroused much interest and resulted in the appointment by Gov. W. J. Holloway of a State Soil Conservation Committee of nine members to make recommendations looking to a solution of this state problem. Efforts of this committee are already having a decided beneficial effect in directing public attention to our soil losses, a survey of which discloses the fact that of 15,781,904 acres of cultivated land, 13,196,735 acres are suffering from erosion losses in this state.

"County agent annual reports show that during the year 1929, 686 adult farmers were trained in terracing work which increased the number of adults capable of doing this work to 1,142 individuals who terraced 27,517 home acres, besides 28,329 neighbor acres. There were 522 juniors trained, and these terraced 5,406 home acres besides 13,804 neighbor acres. A total of 116,051 acres terraced is shown for the year's effort. The same reports show that 7,056 acres were drained by open ditches and 275 acres with tile drains. There were 27 farms that installed irrigation systems on 1,065 acres. There were 120 farms which cleared 2,632 acres of stumps or boulders."

For the year of 1930, the program of the farm engineer and his assistant will be confined mostly along two phases, namely:

(a) Erosion control and moisture conservation by terracing, for men.

(b) The promotion of erosion control practices among 4-H club members.

In connection with terracing schools for adults as well as for juniors many rural school teachers, county commissioners and highway officials are beginning to take part, showing that there is a strong feeling in Oklahoma towards a more progressive movement in the conservation of our soils.

RUDE'S RURAL RHYMES

The Soil

The bard, like lots of other gents
Who sit around upon the fence
While their own gardens grow to weeds,
Can tell the farmer what he needs.

I pray you, Farmer Jones, draw near;
I'll spill some wisdom in your ear.
That scheme of agriculture's rotten
Which leans alone on wheat or cotton.

For Nature's plan is ages old,
To fill her soil with leafy mold.
But we must even Nature better,
Obey in spirit not in letter.

She has no thought for what she's sowing
But scatters daisies in our mowing,
And though her chance-sown flowers be sweet,
A hungry world still calls for wheat.

She sows a lot of weeds and junk in,
While we are strong for corn and punkin,
Instead of quack that spreads all over,
We should plow under rye or clover.

The cow is one of our best bets,
She pays the land her honest debts.
That man will find it hard to live
Who tries to take but never give.
E'en if he wins he is a grafter,
Who'll have to face his sins hereafter.
The game of life no more he'll beat
But shovel coal to earn his heat.

So let us see in Mother Earth,
Who gave us nurture since our birth,
A partner to be justly used,
No easy mark to be abused.

O not for us alone was made
The soil we turn with plow or spade.
When we are done with all our tilling,
Our milking and our silo filling,
Our sons will sow where we have sown
And mow around where we have mown.

If we the soil shall rob and pluck
And all the riches from it suck,
Our children will be out of luck.
So let us follow Nature's plan
And work in humus while we can,
Else when good Gabriel's trump shall blow,
Saint Pete will stand us in a row,
And likely tell us where to go.

EXTENSION WORK IN PAYNE COUNTY, OKLA.

By

LLOYD GODLEY, County Agent

Payne County, Oklahoma

The gentleman here from Texarkana, Mr. Holsey, said some things in which I was very much interested. I did some terracing there just 10 years before he did. I took a 16-foot two-by-four and terraced our farm, and I was very much pleased to visit that farm and to find that those terraces were still standing and had protected the farm from any serious erosion, and were still protecting it about as good as they did at that time.

Oklahoma is a lot newer state than some of the others, and did not start terracing until 1916. I think our accomplishments have been considerable during that length of time. However, when Doctor Bennett was showing those pictures of erosion last night I thought that they were all pictures of Payne county, because we have so many farms which look like those.

Even though we do not have ditches on all of our fields we are having erosion on most of them. In this particular county we have about 160,000 acres of land that the survey shows is eroding very badly. When I saw that survey I wondered if I had not better pick up my hat and leave the county. If I spend two hundred days a year and work eight hours a day and terrace forty acres a day, which I could not do, it would take 20 years to do that job. Thus we can not do it all ourselves. We have passed the personal service stage and the demonstration stage, and we are now ready to do some real work.

I am going to give you some idea of the plan we have been trying out in this county. We, of course, have three county commissioners in this county to deal with in regard to our county agent work. About three years ago the county commissioners purchased 10 levels and left them with the county agent. There has been quite a bit of terracing work done since then. This year I am quite positive that the commissioners will buy one terracing level for each school district in the county. We expect to carry on a very extensive campaign during the next year, and try to get a large per cent of our land terraced. We believe that the only way to do this is to train from three to four farmers in each school district to operate a level. If we should train five men to do terracing work in each school district we can get 350 men in the county trained to run terrace lines. That would leave only about 550 acres of land for each man to run terrace lines on. If we can do that I believe we can get the job done.

Of course, we have people in this county where the A. and M. College is located who do not believe in terracing. A man told me the other day that we are going contrary to the Bible because it says that the land shall become water, and the water land, and that the mountains shall become smooth. It is a big job and it is going to take a lot of effort to get it done. It is an educational process and it has seemed like a slow process to us, but when we see it increase from year to year we can be assured that we are getting results. In a county that is cropped by row crops I do not believe that there is any other system that is going to give the results that terracing will, but of course rotations are necessary also.

A TYPE OF EDUCATION THAT FUNCTIONS ON THE FARM

By
E. B. NELMS
Oklahoma State Supervisor of Vocational Agriculture

The division of vocational agricultural education now operating under the State Board of Education and State Superintendent John Vaughan as director, is doing much toward solving the practical problems of the farm business and the farm home and community in addition to the training that fits for the broader, more liberal education and for the fuller life.

Surveys made in each of the 107 high school communities served, indicate that soil conservation is one of the problems of major importance. Reports indicate that 95 teachers included this in their courses of instruction and training with their 3,000 high school farm boys and about an equal number of adults in evening classes.

Reports for the past year indicate that these groups did terracing on 1135 farms, terracing an aggregate of 50,272 acres. They procured for use in these communities, 138 farm levels and 152 terracing machines. They trained 3,210 high school boys and men in the use of these instruments and report 1362 of these sufficiently skillful to operate without further instruction or assistance.

They report the planting of 66,326 acres in legumes and estimate the need of a million and a half acres of terracing in their service areas.

Evening classes for adults have been conducted in nearly all of the 107 centers, 93 such courses having been conducted for a minimum of 10 meetings. Such courses are followed by a period of supervision of the practices involved, 39 of these classes studied soil problems, 23 dairy problems, 24 poultry problems, five tractor repair and operation. Others include, farm accounting, and farm management, home conveniences and home beautification, gardening, livestock diseases and their control, marketing problems, etc. The number enrolled in these courses was about 2,700. Some courses have been conducted for 86 boys of high school age but not regularly in school. Eighty-nine were trained in day unit courses which are courses for day school students for a more limited portion of time in some particular phase of the farm business.

Incidental to the main business of systematic instruction and training of organized groups followed by supervision of projects and practices, thousands of individual and community services have been performed in connection with the farm business and farm home and community life. Emergencies in the nature of animal diseases, etc., are often taken care of by the agriculture teacher resulting in a great saving to the farmer.

Nearly all of the boys who are students of vocational agriculture take an active part in a national organization, the Future Farmers of America. In this manner, they assume responsibilities and exercise leadership that accomplishes in a splendid way the purposes of vocational education.

Many state and national organizations and industries now recognize the value of this training and offer many valuable prizes in the form of educational tours, cash, and other incentives to these boys, aggregating in value many thousands of dollars each year.

Outstanding members in the state are selected and honored as Junior Master Farmers. From those receiving state honors, a limited number are selected for national honors and called, American Farmers. Of the 35 selected to date, three were from Oklahoma.

The boys receiving training in vocational agriculture are of an average age of 17. In addition to training in operative skills, managerial ability and satisfactory membership in the home and community life, these boys are receiving training for leadership through the agency of a national public speaking contest. Thus, by their study and discussion of the farmers' social and economic problems, the boys are enabled to take their places as leaders.

Many of the groups of boys have been very largely responsible for a community revival of interest in a variety of improved practices through parent and son banquets, project tours, etc., and in some communities, vocational agriculture has been called, "The education that pays dividends" because of the earnings of the boys and the increased margin of profit in farm projects resulting from improved practices of farmers.

I am sure that you are familiar with the fact that the committee appointed by Professor Wilson some years ago came to some good conclusions and contributed much to the education of the country. They concluded that to reach some of these problems, the most effective method was through the schools that are conducted for all the children of the people and that an educational plan was necessary and the most effective education was that directed to the children and young people. The adoption of the Smith-Hughes Bill provided for the training and education in agriculture through the schools. The work has now been extended to all the states for a number of years and is being carried on by those engaged in farming who are above 14 years of age and those who are directly in contact with the problems which confront the farmers. It has come to be a considerable influence as has already been indicated by some of the reports that have been given.

The stupendous figures presented by the man familiar with the state of Texas are really a little bit astounding. Our figures are small because our state is so much smaller. The fact that this work seems to be very effective is due in a measure to the procedure in vocational agriculture teacher training and having had a certain amount of training in the department of agricultural engineering and the assistance of some of the extension workers who are specialized in these lines, they bring before the folks the facts that have been discovered by research and the teachers. The instructors are doing a type of supervision themselves. The problems that are in most need of immediate attention and almost all of the programs such as this one, are set up in such a program that they become a part of our activities. The best of those who average in ages around 17 years are those who have rather definitely committed themselves to the business of farming and they take seriously the training which is given them.

Such facts and figures as have been presented here are made the basis of important instruction. They are kept on the job throughout the year every day. Although the farmers have been convinced of the value of this work, yet they haven't been doing it. The connection between the boys and their fathers has an influence in making them tend toward soil terracing. The teacher in constant contact with the boys gets them to do it. They have organizations and adopt goals and help meet some of these problems. The boys always include as one of their goals the matter of helping to terrace, thus causing to be terraced so many acres of land in their community, and with all the other influences that have been brought to bear and with the help of the boys and their dads has almost presented a way of getting the proposition over which otherwise might be delayed a great deal.

I believe leaders in education have come to realize that the school should train people in terms of the lives that they are to live. They are getting away from the idea that they should train for entrance requirements only. Agriculture is not only for the purpose of making a living but is a life. The type of courses which the teacher presents to the adults is exemplified

by this type of course. The program is gaining in interest and momentum. I maintain that there is not an acre of land that could not be improved by controlling the water that flows over it. If classes are held for adults, such courses are followed by a series of programs. The county agent comes and assists teachers in organizing schools and courses whenever conditions permit. Nearly all of these boys take a great interest in the work. Terracing demonstrations are attempted by the members of the class. They are conducted on the farm of one of the farmers. The organic matter of the soil is important. Crop residues and green manure legumes are factors in soil conservation and improvement. Crop rotation and cultural methods are also factors in soil conservation.

The program is gaining in interest all the time. We are proud of the start that has been made and of the contributions that this service is making toward meeting the problems of this state.

HOW CAN THE PRESS ASSIST IN THE SOIL AND MOISTURE CONSERVATION PROGRAM?

By

FRANK BRIGGS, Editor, Farm and Ranch

Dallas, Texas

The subject as it reads on this program, if interpreted literally, would mean that the press has not done much towards assisting in this work. Of course I know it was not meant that way. We really have been a very prominent factor in the development of the soil and water conservation work here in the southwest. You know the press may have different policies politically speaking, but when it comes right down to constructive measures having to do with the development of education, you will find the press is a unit in this work and they cooperate with each other and they cooperate with all of the other agencies that are interested in that work.

The press has taken a very prominent part in practically every constructive effort that we have had in this country. Why, the press saved this country 100 times before we ever had an A. and M. College, or before we ever had an extension service. It is not our fault that it did not stay saved.

We are conducting our work in the efforts to put over all of these constructive measures that we have been discussing. I want to speak first of the fact that most of the work being done by the various agencies is more or less selfish. It is true with us. I believe there is a legitimate selfishness in the promoting of soil conservation, or anything else. Farm papers are helping in this work because it will increase prosperity in the country, and that will give us more subscriptions and then maybe we can get some more advertising. It is about the same in other branches of the press. It is equally true of the government agencies, because if they do not make good something else is going to take their places.

You can not be an editor of a farm page any great length of time before your interest becomes such that it will oftentimes adopt a policy which someone in the business office might not agree as being to their best interest. I will say for the business management, however, that very seldom do they interfere with an editorial policy if that policy is constructive. The paper that serves its readers first, always serves its advertisers best. If we do our part in developing the resources of the country, and in saving the resources of the country, then the grass will not grow on the streets of our towns, the cob webs will be pushed out of our windows, and we will all prosper. A lot of people have not realized until very recently that all of

the money spent in town comes from the farm. The newspapers, or the press if you want to put it that way, feel that they are important in the development of the work, but we realize that it takes a field man out in the country to finally put it over, but in my opinion if it were not for the press no matter how well versed the field man may be, his work would only be half done. He could not be efficient unless he had this support. Sometimes I feel that some of our field men and some of our specialists do not give publicity the right measure of value.

The power of the press is almost beyond measure, and it is not always exhibited in what is printed in the papers. Those who have had newspaper experience, especially in political years, know that if a candidate is ignored in the papers, he might just as well not enter the race. The indifference of the press towards any movement would set that work back a great many years. Why, I have known candidates to get out and cuss a newspaper in the presence of a reporter for the very reason that he knew the reporter would report what he had said and thereby he would get his name in the paper. I imagine pretty nearly everyone of you looked in this morning's paper to see if your name was in it. If you are doing constructive work, no matter what it is, you like for the press to mention it. The trouble is that you expect the press to spend several thousands of dollars to get this information out of you when you ought to send it in. Suppose a farm newspaper editor had to be a specialist in every line of work. We can not do that. We have to depend upon you and we have to have confidence in you in doing this work. We want to cooperate. I am quite sure that you want to cooperate with us. Sometimes there are things that happen that would indicate that you have the wrong idea concerning the press as it cooperates with other newspapers. While the press is very free to mention your service, very free to mention individuals in the service, and to give you all the credit we can (we do not care for it ourselves, particularly), yet it seems to be the rule that though the press is actually doing a real service and spending many thousands of dollars in putting over programs in connection with the extension service in many states, those publications very seldom appear in anything that is put out by the colleges. I know of a publication in the southwest that has spent, for the past 10 years, many, many thousands of dollars in promoting a service, and promoting a program in which that service is very much interested. I saw a release the other day in which it called attention to that program and the prizes that were to be given, saying that the extension service was doing this in cooperation with a paper published in such and such a city and never mentioned the name of that paper. Then it said that Mr. so and so was going to give some prizes in the short course and it did not give the connection of Mr. so and so whatsoever. This was not in connection with my paper at all. I did not think that was very fair. It has been my pleasure on numerous occasions to say very complimentary things concerning the Master Farmer Movement that the Progressive Farmer is putting over in Texas, and the Oklahoma Farmer-Stockman has been fathering in Oklahoma. I think it is a splendid movement and I am sorry we did not get it ourselves. I am mentioning that to show you that we as newspaper men, especially in the editorial department, are cooperating.

We feel that that is a part of the cooperation, and I want to say that we have received from our Texas Extension Service, from the Oklahoma Extension Service, from Louisiana, Arkansas, and from New Mexico the heartiest kind of cooperation in everything that we have done and I believe that in so doing we have put over the programs to good advantage. I believe that the extension service and the experiment station staff members have an understanding of the value of publicity and I want to assure you before I close that we are with you and that we recognize that these services are the leaders in this work. They are supposed to be the leaders

in the work. The press is not supposed to lead. We only want you to step along fast enough so that we will not be stumbling over your heels all of the time.

The last few years the work that has been done has been so constructive and of such value that our agricultural industry is going to step back into the limelight and again be one of the profitable industries as much as it is the most important that we have in this country. We shall be glad to give what assistance we can on any program that you may put forward. I am not speaking for myself alone. I am speaking for all of the press in the southwest which has to do with this conservation movement.

WHAT THE FEDERAL LAND BANK OF HOUSTON IS DOING

By

A. K. SHORT

Conservation and Terracing Agent

The Federal Land Bank of the Tenth District, located in Houston, Texas, began making loans to farmers in May, 1917. Soon after the bank started making loans, it became apparent to the Board of Directors that definite steps must be taken to insure the perpetuity of the security during the life of the loan. The Board recognized that possibly the greatest controlable menace to land security was soil erosion. They further recognized that, under our clean culture method of farming, terracing was the only means by which farm land could be held within the "metes and bounds," as described in the field notes which formed the basis of the Bank's security.

Some two years after the establishment of the Bank, a terracing clause was incorporated into the deed of trust. This clause states: " * * the land herein described shall be at all times fully protected from deterioration by erosion or lack of drainage, by the construction and maintenance of reasonable, proper and adequate terracing and drainage, and if at any time during which said indebtedness or any part thereof remains unpaid, such terracing and drainage be not constructed and maintained as will fully protect said land from deterioration, of which fact THE FEDERAL LAND BANK OF HOUSTON is to be the sole judge, the said bank may, at its option, declare the entire indebtedness secured hereby immediately due and payable."

From this time on, the Federal Appraisers and the Executive Committee of the Bank look with more and more favor upon those securities offered where an attempt had been, or is being made to conserve the soil. As experience was gained it became more evident that soil conservation was essential to the success of long time amortized loans.

Where securities were sufficient for the amount of loan requested, yet there was some indication of soil erosion, the borrower signed an agreement with the bank to terrace the land before it was again planted to crop. This agreement is still in force. While the terracing clause is in the deed of trust, and this agreement had its effect in stimulating soil conservation, yet it became apparent to the Directors of the Bank that a department should be created whose chief function should be the conservation of securities. Such a department was created in 1927.

While from a legal standpoint the Bank has a right to enforce terracing, yet we fully realize that it would be poor psychology and poor business to approach the problem from an enforcement standpoint. The Department, within the Bank, has a dual function. We entered into an agree-

ment with the Extension Service of the A. and M. College by which we would cooperate in their educational program for the promotion of soil and water conservation. Working in cooperation with the Extension Farm Engineer, Mr. M. R. Bentley, we have had the hearty cooperation of the 349 secretary-treasurers of the National Farm Loan Associations, the vocational teachers, the railroad agricultural agents, and the chambers of commerce,—in fact, the entire State is becoming aroused to the seriousness of this problem.

From the office this Department stays in close touch with all National Farm Loan Associations, and has induced them to make a recheck of all securities within each and every association in this District. When this recheck is completed the secretary-treasurer and Board of Directors of each association pick out those securities where the borrower is not keeping his farm up in shape, and together they visit this individual and encourage him to terrace his land, and to do the other things that are necessary to make his farm safe and more profitable. In the event that a borrower refuses to cooperate with his association, or with the bank, it may become necessary to deprive him of his farm by foreclosure, and to put it into the hands of someone who will take care of the land, and make a success of his farm operations.

In brief, the Federal Land Bank of Houston, is doing everything it possibly can, by education and encouragement, to get its members to conserve soil and water, because this conservation means sound security for the bank's advancement of loans. We are further doing everything possible to encourage the farmers and business men of the State to recognize the necessity of this movement for the prosperity of the farm homes, and business in the trade centers.

SUMMMARY

By

R. H. BUSH

Chilean Nitrate of Soda Educational Bureau, Tyler, Texas

I do not think we can be mistaken in the purpose and responsibility of the experiment stations, extension services or agricultural colleges. Beginning with the organization of the colleges, it has been developed. Later they demanded research work and the experiment stations were organized, followed by the extension services to carry the information into use. They have done such a good job that the demand for commercial educational bureaus has been created.

The difficulty probably comes when the efforts of the official and unofficial institutions need to be correlated. In Texas this led to the formation of the Texas Agricultural Workers' Organization, followed by an effort to correlate the work of individuals and commercial bureaus as contributing factors in the extension program.

There are many ways in which these commercial bureaus can cooperate in official programs such as soil and water conservation. Banks can furnish levels. Other organizations can have representatives at demonstrations or use their implements. As fertilizer representatives, we have planned our demonstrations of soil building, crop rotations and fertilizer tests on terraced land. We place them so as to make crop rotations. We require the farmer to use a cover crop with his cotton and a legume with his corn.

Before the commercial bureaus can cooperate, however, the extension organization must have a definite program for them to follow.

SUMMMARY

By
VICTOR H. SCHOFFELMAYER,
Dallas News, Dallas, Texas

I have enjoyed being with you and have been an interested observer of what has been going on, and I will try to interpret the important points covered so that the reading public may be advised as correctly as possible of this important movement. I am impressed with several things. In a great movement of this kind, a movement which concerns not only the southwest but the Nation, the land value of the southwest is the important factor for it governs its prosperity. Agriculture will be with us until the end of time. Therefore, agriculture affects all business interests, not only in the southwest, but everywhere.

A program of this kind ought to be a little bit more directly to the point of mobilizing the intelligence of the men who control the destinies of this great southwestern empire. I mean by that the land owners. We talk in terms of farmers; we talk in terms of county agents, which is very well and very good, but I doubt if we can get very far if we confine our interests to that. We must reach the big man who has hundreds of thousands invested in this agricultural work—in a Texas farm or an Oklahoma farm. He does not attend these meetings. He gets his information from the press, or from a bulletin. He wants things in a nutshell, which tell him what to do and what this job will cost him. He must have a concise statement. He must know whether it is going to cost him $50.00 per acre to terrace his land, or $10.00, or $25.00.

I hope that when you prepare a program for next year you will give somebody the job of making a list of the cost factors for the different types of soils, designating them by name, giving the investor some things definitely to tie to. Then when the man becomes interested he will know what to do.

We talk about soil and water conservation. In a program of soil and water conservation, we must have reforestation. We must have a forest man to give us what has been done in reforestation. The Federal Farm Board recognizes this and advocates it. Let us have a yellow pine man on this section next year. Let us put the land to timber. Tell the farmer to take it out of cotton and put it back to yellow pine. Let us know how it is paying to reforest our lands.

If we are going to take the marginal man out of this picture let us give him a sensible plan of what he can do in the future. They used to talk about impounding flood waters. You never hear about it any more. That should go into this picture. We should have a comprehensive program. Let us not take an entire day for terracing. It is an important program, but do not give it all of the time.

OFFICERS ELECTED

JUNE 20, 1930

SOUTHWESTERN SOIL AND WATER CONSERVATION CONGRESS

President - - - - - - - - C. P. BLACKWELL
Dean of Agriculture and Director of Experiment Station
Oklahoma A. and M. College, Stillwater

Vice-President - - - - - - - - - M. F. MILLER
Assistant Dean, College of Agriculture
University of Missouri, Columbia

Secretary - - - - - - - - - - - - - - - - H. C. POTTS
Director of Agricultural Short Courses
Oklahoma A. and M. College, Stillwater

RESOLUTIONS

WHEREAS, financial institutions making loans for the purchase of lands or for crop production are in a position to become important factors in the development of a permanent agriculture, through urging and encouraging the conservation of soil and moisture,

THEREFORE, be it resolved that this convention go on record as requesting that all institutions making loans for the purchase of land or for crop production join the Extension service and the Experiment station of each state in a conservation program to the end that our soils be conserved and that moisture be controlled, and fertility restored, by terracing, and by the adoption of proper cropping systems, and intelligent methods of soil management.

BE IT FURTHER RESOLVED that the Director of Extension service of each state represented in this convention transmit this request to the President and Chairman of the Agricultural Committee of his state, to the Agricultural Committee of his State Bankers' Association, and to other agencies making loans on lands, or interested in other ways in the conservation of the soil.

This conference also recommends that the various legislatures give recognition to the immediate need for protecting public lands or other lands in which the Government may be interested, by making adequate appropriations for the construction and maintenance of terraces, and for the support of other methods deemed necessary to the conservation and reclammation of our soils.

BE IT FURTHER RESOLVED that the various legislatures pass the necessary laws to encourage cooperation of county governments in aiding in a conservation program by renting road machinery and other available equipment used in the construction of terraces and drains.

BE IT FURTHER RESOLVED that the legislatures of our several states and the National Congress are especially thanked for their liberal support of soil and moisture conservation movements in this southwestern area, both in the matter of appropriation of public funds and in the assignment of their agronomic and engineering research workers to the active aid of the various research projects under way in these states.

In connection with the matter of flood control, it is the opinion of this body that hydraulic, soil, and economic surveys should be conducted on individual stream watersheds in order to determine the feasibility and the most effective methods of soil and water conservation. The latter to include the use of water for irrigation, power, and recreational purposes. An example of such a survey for the purpose of stream unit control may be found in the proposed project of the Brazos river conservation district of Texas, which promises to become an outstanding example of such cooperation in the matter of stream unit control.

The officials of the Oklahoma A. and M. College and the people of Stillwater have furnished every facility for this conference, and the visiting delegates have been accorded every courtesy to the end that this has been a most successful session, and this body is accordingly grateful for such hospitality. Dean C. P. Blackwell is accorded especial thanks for his untiring efforts in making every detail complete for the success of this conference. Special mention should be made of Clay Potts for his untiring efforts in behalf of the success of each session of this conference, and Miss Littrell and Mrs. Yeats, who have so faithfully made stenographic records of the proceedings of the conference. We also express our appreciation of the splendid meal service that has been given in the Tiger Tavern during this conference.

BE IT FURTHER RESOLVED that an executive committee made up of a representative from each state be appointed by the President of the Southwest Soil and Moisture Conservation Congress to decide upon the time and place for the next conference, the program for same, and such other business as may need attention when this Congress is not in session.

Said committee should be appointed after conferring with experiment station and extension directors of each state concerned.

DELEGATES AND VISITORS

Name	Address	Title or Occupation
Abercrombie, E. S.,	Prescott, Arkansas;	
Atkins, H. L., Jr.,	Dallas, Texas;	Progressive Farmer Teacher
Austin, J. B.,	Granite, Okla.;	Teacher
Baird, Ray O.,	Stillwater, Okla.;	Local Supervisor, Voc. Agri.
Baird, R. W.	Tyler, Texas;	U. S. D. A., Division Agricultural Engineering
Bartel, F. A.,	Statesville, N. C.	U. S. D. A., Division Agricultural Engineering
Bennett, K. C.,	Stillwater, Okla.;	Student
Bennett, H. G.,	Stillwater, Okla.;	President, O. A. M. C.
Bennett, H. H.,	Washington, D. C.;	Bureau Chemistry of Soils
Bentley, Mrs. M. R.,	Bryan, Texas;	Staff writer, Bryan Daily Eagle Repr. Southern Agriculturist
Bentley, M. R.,	College Station, Texas;	A. and M. College
Bergschneider, H. E.,	Guthrie, Okla.;	A. and M. College
Blackwell, C. P.,	Stillwater, Okla.;	Dean of Agric., O. A. M. C.
Briggs, Frank,	Dallas, Texas;	Farm and Ranch
Brantley, J. B.,	Jefferson, Okla.;	Vocational Teacher
Brown, W. R.,	Delhi, Okla.;	Vocational Teacher
Brown, C. H.,	Breckenridge, Tex.;	President, Brown Tool Co.
Bunyard, C. L.,	Collinsville, Okla.;	Vocational Teacher
Burleson, D. J.,	Fayetteville, Ark.;	Agri. Extension Division

Name	Address	Title or Occupation
Bush, R. H.,	Tyler, Texas;	Mgr. Chilean Nitrate Soda Educational Bureau
Byrd, C. W.,	Corsicana, Texas;	Cashier, Cars, Grader & Machine Company
Campbell, R. S.,	Las Cruces, N. Mex.;	Forest Service
Carleton, Howard, Jr.,	Deer Creek, Okla.;	Vocational Teacher
Castle, E. L.,	Wellston, Okla.;	Vocational Teacher
Chance, R. J.,	Chickasha, Okla.;	Vocational Teacher
Crosnoe, S. M.,	Garber, Okla.;	Vocational Teacher
Davis, R. H.,	Hays, Kansas;	Bureau of Chemistry and Soils
Dickson, R. E.,	Spur, Texas;	Experiment Station
Dilts, Arthur,	Hunter, Okla.;	Vocational Teacher
Dinan, L. F.,	Galveston, Texas;	Santa Fe Agri. Agent
Drake, Raymond R.,	Hays, Kansas;	U. S. D. A., Division Agricultural Eng., Bureau Public Roads
Duley, F. L.,	Manhattan, Kan.;	State Agricultural College
Durland, W. D.,	St. Louis, Mo.;	Forester, Mo. Pacific Lines
English, W. L.,	Springfield, Mo.;	Supervisor Agriculture, Frisco Ry.
Fitzhugh, J. G.,	Galveston, Texas;	G. C. & S. Fe Railroad
Griffith, W. F.,	Dallas, Texas;	Sanger Investment Co.
Gilbert, G. O.,	Talihina, Okla.;	Frisco Agricultural Agent
Goddard, Ira T.,	Guthrie, Okla.;	Assistant Agronomist, O.A.M.C.
Godley, Lloyd,	Stillwater, Okla.;	County Agent
Gould, Chas. N.,	Norman, Okla.;	State Geologist, Oklahoma Univ.
Green, J. L.,	Snyder, Okla.;	Vocational Teacher
Green, W. J.,	Stillwater, Okla.;	District Agent, Southeast, Extension Service
Harper, H. J.,	Stillwater, Okla.;	F. C. & S. Dept., O. A. M. C.
Hazen, L. E.,	Stillwater, Okla.;	Agricultural Engineering Dept., O. A. M. C.
Hill, Bryce	Terral, Okla.;	
Holacy, W. R.,	New Boston, Texas;	County Agent
Holloway, W. J.,	Oklahoma City;	Governor of Oklahoma
Hollar, Ira J.,	Stillwater, Okla.,	Poultry Specialist
Hoover, R. L.,	Oklahoma City;	Oklahoma Tractor & Equipment Company
Hutchison, W. R.,	Newkirk, Okla.;	County Agent
Jackson, A. D.,	College Station, Texas;	Editor Expt. Sta. Publication
Jeffords, T. W.,	St. Louis, Mo.;	Agri. Agent, M. K. T. Ry.
Jones, D. L.,	Lubbock, Texas;	Experiment Station
Jones, Lewis A.,	Washington, D. C.;	U. S. D. A., Division Agricultural Engineering
Kirkpatrick, A. G.,	Perkins, Okla.;	Vocational Teacher
Knobel, E. W.,	Peabody, Kansas;	Soil Survey
Lentz, G. H.,	New Orleans, La.;	Forest Service
Ligon, L. L.,	Stillwater, Okla.;	F. C. S. Dept., O. A. M. C.
Lewis, R. O.,	Manhattan, Kan.;	Soil Survey
Lewis, T. B.,	Groesbeck, Texas;	County Agent
McCall, A. G.,	Washington, D. C.;	Bureau of Chemistry & Soils
McGregor, J. I.,	Houston, Texas;	General Agricultural Agent, S. P. Lines
McGrew, P. C.,	Guthrie, Okla.;	U. S. D. A., Division Agricultural Eng., Bureau Public Roads

Name	Address	Title or Occupation
McNallie, G. V.,	Tyler, Texas;	Agri. Dept. St. L. S. W. Ry.
McPheeters, W. H.,	Stillwater, Okla.;	Field Agri. Eng. P. C. A.
Martin, O. B.,	College Station, Texas;	Director Extension Work
Merrifield, Fred R.,	Stillwater, Okla.;	District Agent, Northwest Extension Service
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